DOCUMENT RESUME

ED 242 539 SE 044 299

AUTHOR	Kolb, James A.
TITLE	Marine Science Career Awareness, Grade Four. Revised.
INSTITUTION	Educational Services District 114, Marine Science Center, Poulsbo, WA.
PUB DATE	84
NOTE	365p.; For related documents, see ED 236 037-041.
AVAILABLE FROM	James A. Kolb, Marine Science Center, 17771 Fjord Drive, NE, Poulsbo, WA 98370 ($25.00).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Animals; *Career Awareness; *Elementary School Science; Environmental Education; Fisheries; Grade 4; Ichthyology; Intermediate Grades; Learning Activities; *Marine Biology; *Marine Education; Oceanography; *Science Activities; Science Careers; Science Education; Units of Study

ABSTRACT

This unit, one of a series designed to develop and foster an understanding of the marine environment, presents marine science activities for fourth grade students. The unit, focusing on the various types of careers and occupations connected directly and indirectly with marine science, is divided into sections dealing with: commerce and intertidal beaches; commercial crabbing; harvesting clams; harvesting oysters; commercial shrimping; commerical fishing; and aquaculture and mariculture. Each section has a student text with related activities. Each student text is preceded by a teacher section containing information on how to use the section, additional information, and items requiring advance planning. Each activity is also preceded by a teacher background section providing additional information about the activity, including teaching hints and answer key for activities. Important vocabulary words/terms are listed in the teacher background sections; they are also underlined in the student text. Activities are designed to enhance reading as well as investigative skills; several activities provide practice in mathematics skills. Although all activities can be modified to suit individual needs or can be used "as is," it is strongly recommended that they be performed along with the readings/discussions found in student text material. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED242539

4 MARINE SCIENCE CAREER AWARENESS

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)
☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
- Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Marine
Science
Center

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY
James A. Kolb

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SE044299

MARINE SCIENCE CAREER AWARENESS

GRADE FOUR

MARINE SCIENCE CENTER
MARINE SCIENCE PROJECT: FOR SEA
Educational Service District 114
Poulsbo, Washington 98310

ESEA TITLE IV-C
James A. Kolb
Project Developer
Author/Editor

Revised 1984

MARINE SCIENCE CAREER AWARENESS -- GRADE FOUR

Table of Contents

Introduction 1

A Conceptual Scheme for Aquatic Studies 4

Marine Aquaria in the Classroom 11

A Selected Bibliography of Children's Literature of the Sea 15

Bibliography of Juvenile Information Books of the Sea 23

Commerce and the Intertidal Beaches 39

- Teacher Background - Commerce and the Intertidal Beaches 41
- Commerce and the Intertidal Beaches - student text 49
- Teacher Background - Jobs, Jobs, Jobs 55
- Jobs, Jobs, Jobs! - student activity 57
- Teacher Background - Transportation 59
- Transportation - student text 63
- Intertidal Ports - student activity 71
- Teacher Background - Plimsoll Floats! 73
- Plimsoll Floats! - student activity 77
- Teacher Background - The Great Boat Float 85
- The Great Boat Float - student activity 87
- Teacher Background - Marsh Beach: A Simulation of Coastal Planning . 97
- Marsh Beach: A Simulation of Coastal Planning - student text 103
- Suggested Additional Activities 113

Commercial Crabbing 115

- Teacher Background - Commercial Crabbing 117
- Commercial Crabbing - student text 119
- Teacher Background - Crabs 129
- Crabs - student activity 131
- Teacher Background - What A Story! 133
- What A Story! - student activity 135
- Teacher Background - Stuffed Crab 137
- Stuffed Crab - student activity 139
- Teacher Background - Observing the Living Crab 143
- Observing the Living Crab - student activity 147
- Teacher Background - Scrambled Crab 151
- Scrambled Crab - student activity 153
- Suggested Additional Activities 155

- Harvesting Clams 157
  - Teacher Background - Harvesting Clams 159
  - Harvesting Clams - student text 161
  - Teacher Background - Gooey Ducks? 169
  - Gooey Duck? - student text 173
  - Teacher Background - Insides Out 177
  - Insides Out - student activity 179
  - Teacher Background - Open Sesame 187
  - Open Sesame - student activity 189
  - Teacher Background - Open Sesame Puzzlegram 193
  - Open Sesame Puzzlegram 195
  - Teacher Background - Hot Cross Clams 197
  - Hot Cross Clams - student activity 199
  - Teacher Background - Creative Writing 203
  - Open Sesame-Creative Writing - student activity 205
  - Suggested Additional Activities 207
- Harvesting Oysters 209
  - Teacher Background - Harvesting Oysters 211
  - Harvesting Oysters - student text 213
  - Teacher Background - Oyster Tides 217
  - Oyster Tides - student activity 223
  - Teacher Background - Folding Oysters 227
  - Folding Oysters - student activity 229
  - Teacher Background - That's Life 237
  - That's Life - student activity 239
  - Teacher Background - "Guess Who's Coming For Dinner" 241
  - "Guess Who's Coming For Dinner" - student activity 243
  - Suggested Additional Activities 249
- Commercial Shrimping 251
  - Teacher Background - Commercial Shrimping 253
  - Commercial Shrimping - student text and activity 257
  - Teacher Background - The Shrimp Boats Are A-Coming 265
  - The Shrimp Boats Are A-Coming - student text 267
  - Teacher Background - How Hot Is Too Hot 273
  - How Hot Is Too Hot - student activity 275
  - Teacher Background - Only Half the Story 281
  - Only Half the Story - student activity 283
  - Suggested Additional Activities 285
- Commercial Fishing 287
  - Teacher Background - Commercial Fishing 289
  - Commercial Fishing - student text 297
  - Teacher Background - Fins 317
  - Fins - student activity 319
  - Teacher Background - Name That Fish 321
  - Name That Fish - student activity 325

Commercial Fishing (cont'd)

Teacher Background - Healthy Heart Food 329
Healthy Heart Food - student text 331
Teacher Background - The Dolphin Controversy 335
The Dolphin Controversy - student text and activity 339
Teacher Background - The Seeing Ear 347
The Seeing Ear - student text and activity 351
Teacher Background - Food From the Sea 361
Food From the Sea - student text and activity 365
Teacher Background - Gyotaku - Japanese Fish Printing 375
Gyotaku - Japanese Fish Printing - student activity 379
Teacher Background - Word Search 381
Word Search - student activity 383
Suggested Additional Activities 385

Aquaculture and Mariculture 387

Teacher Background - Aquaculture and Mariculture 389
Aquaculture and Mariculture - student text 397
Teacher Background - Open for Business 415
Open for Business - student text 417
Teacher Background - Fish Farmer 419
Fish Farmer - student activity 421
Teacher Background - World in a Jar 425
World in a Jar - student activity 435
Suggested Additional Activities 441

Send-In Page 443

MARINE SCIENCE CAREER AWARENESS - GRADE FOUR

INTRODUCTION

The history of the United States is strongly tied to the seas. The future of the United States will also be strongly tied to the marine world. It is important that the leaders and the citizenry alike have a familiarity with the marine environment that will permit them to make wise choices in resolving the conflicts that are sure to arise over use of the ocean's resources. Marine Science Career Awareness is designed to contribute to the knowledge necessary to make these sound decisions. In the development of the Fourth Grade Marine Science Career Awareness, our goal has been to provide an opportunity for both the teacher and the student to become aware of the various types of careers and occupations connected directly and indirectly with marine science.

This unit has been designed to be used in its entirety or just in part. It is recommended that the teacher incorporate his or her own ideas, experiences, and background to elaborate the subject material. It is important to develop the natural enthusiasm children have for learning about the sea. This is the time to add a bulletin board dealing with the marine world to your classroom. Displays of living and non-living marine creatures are also recommended. Use your imagination to create an exciting classroom atmosphere. National Geographic magazines are excellent scources of pictures. Incorporate some of the books listed in the Children's Books about the Marine Environment section into your reading program. Investigate the audio-visual materials available from your supplier. Have students bring in their shell collections and other related items. This unit has the potential for not only being worthwhile, it can be fun!

The unit is divided into several sections. Each section has a student text and student activities. Each student text is preceded by a Teacher Background section which contains hints on how to use the section, additional information, and items for which advanced planning is required. Each activity is also preceded by a Teacher Background section. This section gives additional information about the activity including teaching hints and answer key. Skim the contents of the unit to discover the organizational scheme. Please read the text and activities before you use them. The materials have all been prepared with ease of duplication in mind. Please feel free to duplicate any and all materials you need to effectively utilize this unit with your class. Important vocabulary terms are listed in the Key Word section of the Teacher Background. They are also underlined in the text. The words are defined in the text, either directly or by context. All of the units have activities accompanying the text. Most require few materials. It is strongly recommended that the activities be performed along with the reading and discussion of the text. The activities are designed to enhance reading skills as well as investigational skills. Some activities provide practice in math skills. The activities can be modified to suit your particular needs but will work "as is".

The unit also incorporates a variety of laboratory experiences using live animals and related equipment at the Marine Science Center. In addition, the teacher is given the opportunity of inservice assistance with the unit as well as the opportunity to use the many resources available through the Marine Science Center staff. Ouf staff is available to you to give assistance in providing resource material and in setting up the unit of study. Please contact one of our staff members by calling (206) 779-5549.

A list of resource people that are willing to be involved and assist you with your unit of studies is listed in the resource portion of this unit.

At the end of the text and activity section, you will find a send-in page. We would like you to use it to let us know how much you liked or disliked the unit. If you have some marine activity that you have tried successfully with children, please let us know about it. Perhaps we can incorporate it in future revisions.

This unit is one of a series designed to develop and foster an understanding of the marine environment. Other units in the series include:

Marine Science Activities Grade 2

Marine Science Activities --The Marine Environment Grade 6

Marine Biology and Oceanography Grades 7 - 9

Marine Biology and Oceanography Grades 9 - 12

Marine Science Career Awareness - Grade Four has been prepared with funds from ESEA Title IV-C Grant Number 35462 administered by Educational Service District 114 and the Superintendent of Public Instruction.

James A. Kolb
Project Developer
Author/Editor

Project COAST

A CONCEPTUAL SCHEME FOR AQUATIC STUDIES

by Drs. Bob Stegner and Maura Geens-Tyrrel

1. WATER EXHIBITS IMPORTANT PROPERTIES WHICH PLAY A VITAL ROLE ON EARTH

1.1 The earth is unique in our solar system.

- 1.11 The earth's mass is such that the planet has an atmosphere which supports life.
- 1.12 Water and carbon dioxide are the most abundant compounds on the earth's surface.
- 1.13 The earth's proximity to the sun enables water to exist in three phases; solid, liquid and gas.

1.2 The earth's water is constantly recycled through a process known as the hydrologic cycle.

- 1.21 The hydrologic cycle consists of the process of evaporation, condensation, precipitation and percolation.
- 1.22 The earth's surface water is constantly recycled through the oceans.
- 1.23 Water is purified through the hydrologic cycle.
- 1.24 Naturally occurring processes and human activities affect the hydrologic cycle.

1.3 Water has unique chemical and physical properties.

- 1.31 The chemical and physical behavior of water results from the geometry of the water molecule.
- 1.32 Large amounts of heat are involved in changing water from one state to another.
- 1.33 Water is a very effective solvent.
- 1.34 Dissolved and suspended substances affect the properties of water.
- 1.35 Water in nature usually contains gases, organic compounds and minerals.
- 1.36 Many elements dissolved in water are cycled through biological, geological, and chemical systems.

2. AQUATIC ENVIRONMENTS INTERACT WITH THE LAND AND ATMOSPHERE

2.1 The oceans constitute the largest aquatic environment on earth.

- 2.11 Oceans formed early in the history of the earth.
- 2.12 Approximately 70% of the earth's surface is covered by water.
- 2.13 Approximately 97% of the earth's water is salt water.

2.2 The ocean waters are influenced by the earth's movements and position in the solar system.

    2.21 Ocean currents are affected by the absorption of solar energy.

    2.22 Ocean currents are affected by the earth's rotation.

    2.23 Tides result from gravitational forces of the earth, the moon, and the sun.

2.3 Energy is transferred where water meets air, land, or subsurface topography.

    2.31 Air movements generate waves and surface currents.

    2.32 Moving water constantly shapes land forms.

    2.33 Subsurface topography is constantly changing.

    2.34 Land sea floor movements generate waves.

    2.35 Ocean currents affect the earth's semi-permanent wind patterns.

    2.36 The earth's water masses are the major factor influencing climates.

    2.37 Subsurface topography affects tides, currents, and waves.

2.4 Materials carried from land masses influence the physical and chemical features of lakes, rivers, wetlands and oceans.

    2.41 Water, ice and air carry organic and inorganic materials into lakes, rivers, wetlands and oceans.

    2.42 Fresh water from the land dilutes ocean water.

2.5 Changes in aquatic environments occur naturally.

    2.51 Changes can occur over long periods of time or can occur quickly.

    2.52 Changes in aquatic environments affect the land and atmosphere.

    2.53 Changes occurring on land and in the atmosphere affect the aquatic environment.

3. AQUATIC ORGANISMS INTERACT IN COMPLEX ECOSYSTEMS

3.1 Life probably originated in the aquatic environment.

    3.11 Water aided the chemical evolution of life forms.

    3.12 Aquatic environments have supported and continue to support the evolution of a diversity of species.

3.2 The aquatic environment enables terrestrial life forms to evolve.

    3.21 The majority of the oxygen in the atmosphere has been and continues to be produced by one-celled aquatic plants.

3.22 Ultra-violet radiation from the sun acts upon oxygen in the atmosphere to produce the ozone layer.

3.23 The ozone layer, which absorbs most of the harmful ultraviolet radiation, facilitated the evolution of terrestrial organisms from aquatic organisms.

3.24 Throughout the evolutionary process water has been and is today essential to the survival of all organisms.

3.3 Aquatic organisms adapt to their environments in different ways.

3.31 Aquatic organisms adapt developmentally, structurally, functionally, and behaviorally to their environments.

3.32 Organisms in aquatic communities interact with their environments.

3.33 Populations of aquatic organisms are unevenly distributed.

3.4 Aquatic ecosystems depend on a constant flow of energy and the recycling of materials.

3.41 Aquatic ecosystems are maintained by energy which comes from the sun.

3.42 Aquatic plants convert solar energy to food energy.

3.43 Aquatic organisms depend on life sustaining minerals which are recycled through the ecosystem.

3.44 Aquatic bacteria reduce organic materials to simpler forms.

3.5 Stable ecosystems are essential to the health of the aquatic environment.

3.51 The stability of aquatic ecosystems tends to be directly proportional to the diversity of their population.

3.52 The stability of aquatic ecosystems tends to be directly proportional to the complexity of relationships among the populations.

4. PEOPLE ARE PART OF THE AQUATIC ENVIRONMENT

4.1 The aquatic environment has affected the course of history and the development of human cultures.

4.11 Waterways have served as routes for the dispersal and concentration of human populations and cultures and for military and commercial transport.

4.12 Proximity to aquatic environments and the availability of aquatic resources have influenced the values, religion, lifestyles, politics, science and technology, arts and humanities of cultures.

4.2 People use the aquatic environment.

4.21 People collect and culture aquatic resources.

4.22 People use water for energy production.

4.23 People change the pathways of water for their own benefit.

4.24 People's activities change the contours of shorelines and the ocean floor.

4.25 Use of aquatic environments can degrade habitats and deplete aquatic species.

4.26 People change aquatic ecosystems by adding pollutants to land, air, and water.

4.27 People make laws which affect aquatic systems.

4.3 The lifestyle which people choose has an affect on aquatic environments.

4.31 The majority of the world's population lives near bodies of water.

4.32 Water recreation is important to some people's lifestyle.

4.33 Misuse of the shoreline zone can result in complex environmental problems.

4.4 People work in careers which involve the aquatic environment.

4.41 Aquatic careers involve varying employment opportunities, wages, working conditions and educational requirements.

5. PEOPLE CAN ACT TO PRESERVE THE HEALTH OF AQUATIC ENVIRONMENTS.

5.1 Existing technology affects the health of aquatic environments and their usefulness to people.

5.11 Technologies have been developed to increase the usefulness of aquatic environments for humans.

5.12 Some technological development has adversely affected the aquatic environment.

5.13 Technologies have been developed to improve the health of aquatic environments and to rectify adverse effects caused by people.

5.2 Political and legal systems must concern themselves with the health of aquatic environments from a local, regional, national and international perspective.

5.21 Aquatic ecosystems do not conform to political boundaries.

5.22 Acting alone or in large groups, people can use their political and/or legal systems to resolve water issues.

5.23 Aquatic laws influence relations between countries.

5.3 Ethical choices affect the aquatic environment.

5.31 Knowledge and understanding of the aquatic environment affects ethical choices.

5.32 People have different ethical standards which frequently result in conflict over aquatic issues.

5.4 The aesthetic perceptions of humans affect their relationship to the world of water.

5.41 Involvement with aquatic environments has influenced the aesthetic expression of people.

5.42 People value aesthetic interpretations of the aquatic environment.

5.5 Economic considerations often play a role in decisions which people make concerning aquatic environments.

5.51 When people make decisions involving the aquatic environment, they consider the cost in relation to the benefits to be derived.

5.52 Many important aspects of the aquatic environment cannot be measured in terms of economic factors.

5.6 Aquatic education affects people's knowledge of, attitude toward and involvement with the aquatic environment.

5.61 Aquatic education is essential for all people.

5.62 Aquatic education involves many disciplines.

MARINE AQUARIA IN THE CLASSROOM

MARINE AQUARIA IN THE CLASSROOM

From kindergarten to graduate school the marine aquarium arouses interest and enthusiasm. Traditionally, marine aquaria have been very expensive and difficult to operate. The recent technological improvements have reduced the cost and labor involved in maintaing a marine aquarium. Teachers should give every consideration to the establishment of a marine aquarium in the classroom.

Before embarking on a marine aquarium project, some basic questions need to be resolved. These include: How much can I afford (do I want) to spend in time? in effort? A very simple set-up to keep hermit crabs can be had for a few dollars while an elaborate temperature-controlled aquarium can cost thousand dollars.

Regardless of the type of aquarium chosen some facts pertain to all:

1. Aquarium tank - use only tanks made from all glass, plastic, epoxy-coated wood, or fiberglass. No metal edges. While a 10 gallon aquarium may be used in some cases, 20 gallon size is the preferred minimum.
2. Sub-gravel filter - a good sub-gravel filter should be employed to help control biological wastes.
3. Air pump - you can seldom have too much air. Get a pump with a capacity high enough to effectively run the sub-gravel filtration system.
4. Gravel filtrant - use dolomite, crushed coral rock, or crushed oyster shell. Builders gravel has iron and similiar materials which will harm or kill marine organisms.
5. Thermometer/Hydrometer - tools useful in determining the salinity and temperature of the water.
6. Seawater - Synthetic sea salts may be used to make salt water solutions if you are more than a day's drive from natural seawater.
7. Food - Depends upon the type of organism. Use only high quality foods and remove uneaten food from aquarium.

If you buy a marine aquarium kit, instructions for set up will be included. Otherwise, a few hints are given below:

1. Talk to people who have had marine aquaria. (e.g. other teachers, pet shops, etc.) Their assistance can be invaluable.
2. Place the aquarium in desired location. Away from direct sunlight but near an electrical outlet.
3. Install sub-gravel filter.
4. Wash gravel in tap water. Spread evenly over the filter.
5. Fill tank with correct amount of water needed to make sea salt solution (follow directions of manufacturer). Or fill to 1 or 2 inches from top with natural sea water if available.
6. Run filtration system for 24 hours to mix solution.
7. Shut off filter. Check specific gravity by floating hydrometer and reading it at the water-line: it should read between 1/021 and 1.023 when the water temperature is 68-77° F (20-25° c). If necessary adjust by adding tap water to lower reading.
8. Run filter for 14 days. Some aquarists recommend placing one or two hardy specimens in the tank for this period. If available, hermit crabs or the like should be added to help condition the water.
9. Add specimens to tank. If you order the animals from a biological supply house they will come with directions. Otherwise, open each plastic bag of specimens in subdued light and float it on top of the water in the aquarium for 15 to 30 minutes. In this period trickle water from the tank into the bags to slowly equalize temperature and salinity. This is the crucial step. Now add animals to tank, one at a time. (If animals act nervous or contract, stop operation until they have adjusted.)
10. The specimens will live several months without being fed, but to keep them healthy adopt a simple, regular feeding program. Feed carnivorous invertebrates (sea anemones, crabs, horseshoe crabs, starfish, etc.) once a week: they take small minnows, shrimp, earthworms, bits of lean beef. Filter-feeders (barnacles, hydroids, sea cucumbers, clams, etc.) eat Daphnia, brine shrimp, algae, protozoa, or dried fish foods. Herbivorous species (sea hares, sea urchins, turbo snails, etc.) may be fed lettuce or spinach.

Avoid water pollution--remove all uneaten food.

Once the system is operating, care is easy. Each day, a person familiar with the aquarium should check filters and specimens. Dead animals must be removed at once. Add tapwater as often as necessary to keep water at level marked. Do not add salt water since this will increase the salinity.

Though sea-salts don't disintegrate, specimens will stay healthier with partial water changes at regular intervals. Suggestion: once a month, add a few gallons of new seawater solution after siphoning off same amount from tank.

For algae control, scrape tank walls every two weeks.

The above suggestions apply to all marine aquaria. If you live in a Northern latitude, and want to keep local cold water species, you will need a refrigeration unit of some description. Instructions for home-made units can be found in reference books on marine aquaria. Ready-made refrigerated aquaria are available and expensive.

If after reading the above, you are discouraged, take heart. Hundreds of teachers are operating successful in-class marine aquaria. The technical problmes can be overcome. If you feel that it is unquestionably "out of your league" and you cannot obtain help from another source, do not completely forsake the idea. A simple aquarium for hermit crabs can be set up for a very few dollars. Solicit donations from students--all glass aquaria are plentiful. Go to a pet shop and buy a hermit crab or two and get instructions on how to keep them alive. It can be fun! At the very least, set up a freshwater aquarium with goldfish or tropical fish so that you can use a living example when you talk about aquatic organisms. Here is a real opportunity to use all that creativity that got you into teaching in the first place. Good luck!

RECOMMENDED READING

James, Daniel E.	*Carolina Marine Aquaria*. Carolina Biological Supply Co. 2700 York Road, Burlington, North Carolina 27215. 1974. This booklet is available from the above address and offers valuable assistance as well as information for single organisms or complete kits. 24 pages. ($1.00)
King, John M. and Spotte, Stephen	*Marine Aquariums in the Research Laboratory*. Aquarium Systems Inc. 33208 Lakeland Blvd., Eastlake, Ohio 44094. 1974. Describes tank set up and maintenance as well as offering experiments which can be performed using marine aquaria. Also advertises Instant Ocean products. 39 pages. ($2.00)
Straughan, Robert P. L.	*The Salt-Water Aquarium in the Home*, 2nd edition. A. S. Barnes and Co. New York 1970. A comprehensive reference. 360 pages. ($12.50)

CHILDREN'S LITERATURE
OF THE
SEA
TEXAS A&M UNIVERSITY

A SELECTED BIBLIOGRAPHY OF
CHILDREN'S LITERATURE OF THE SEA

Norma Bagnall
Department of English
Texas A&M University
College Station, TX 77843

September, 1978

Aaron, Chester, Spill. Atheneum, 1977.
Grades 4-6.

Andersen, Hams Christian, The Great Sea Serpent.

——— The Little Mermaid. N.Y. Harper-Row, 1971
Grades 3 - 6.

Ardizzone, Edward, Little Tim and the Brave Sea Captain, Walck, 1955.
Preschool - up.

——— Peter the Wanderer, Walck, 1964.
Preschool - up.

——— Tim All Alone, Walck, 1957.
Preschool - up.

——— Tim and Lucy Go to Sea, Walck, 1958.
Preschool - up.

——— Tim to The Lighthouse, Walck, 1968.
Preschool - up.

——— Tim to the Rescue. Walck, 1949.
Preschool - up.

——— Tim's Last Voyage. Walck, 1973.
Preschool - up.

——— The Young Ardizzone. Macmillan, 1971.
Autobiography - middle grades - adult.

Babbitt, Natalie, The Eyes of the Amaryllis. Farrar, Straus & Giroux, 1977.
Grades 4-8.

Boston, Lucy, The Sea Egg, Harcourt Brace, 1967.
Grades 4-6.

Brown, Margaret Wise, Seashore Noisy Book. Harper Row, 1941.
Preschool - 3.

Cameron, Eleanor, The Mysterious Christmas Shell. Little Brown, 1962.
Grades 4-6.

——— A Spell Is Cast. Little Brown, 1964.
Grades 4 - 6.

——— The Terrible Churnadryne. Little Brown, 1959.
Grades 4 - 6.

Carpelan, Bo G.B. Bow Island; The Story of a Summer That Was Different tran. from Swedish by Sheila La Farge. XIX Delacorte Press, 1974.
Grades 5-8.

Clemons, Elizabeth, *Shells Are Where You Find Them*. Knopf, 1960.
Grades 2-4.

Coatsworth, Elizabeth, *Fair American*. MacMillan 1968.
Grades 3-7.

Cooper, Susan, *Greenwitch*, Atheneum, 1974.
Grades 4-8.

——— *Over Sea, Under Stone*. Harcourt Brace, 1966.
Grades 4 - 8.

Dana, Richard H. *Two Years Before the Mast*, Airmont (paper)
Young Adult.

Darwin, Charles, *The Voyage of the Beagle*, Harper Row, 1959.
(abridged by Millicent Selsam)
Grades 7-9.

Defoe, Daniel, *Robinson Crusoe*. Macmillan, 1962. (also about 20 other editions, some illustrated, some abridged)
Grades 4 - up.

Farber, Norma, *A Ship in a Storm on the Way to Tarshish*, Morrow, 1977.
Preschool - 3.

——— *Where's Gomer?* Dutton, 1974.
Preschool - 3.

Fox, Paula, *The Slave Dancer*, Dell, 1975.
Grades 4-8.

Goudey, Alice E., *Houses from the Sea*, Scribner, 1959.
Information book.
Kindergarten - up.

Haas, Irene, *The Maggie B*, Atheneum, 1975.
Preschool - 3.

Harris, Rosemary. *The Seal Singing*. Collier.

Haugaard, Erik Christian, *Orphans of the Wind*. Dell, 1969.
Grades 2-6.

Henry, Marguerite, *Misty of Chincoteaque*, Rand McNally, 1949.
Grades 4-6.

——— *Sea Star*. Rand McNally, 1949.
Grades 4 - 6.

Heyerdahl, Thor, *Kon-Tiki*, Rand McNally, 1950.
Grades 7 - up.

——— *Kon-Tiki for Young People*. Rand McNally, 1960.
Grades 4 - up.

Holling C. Holling, *Seabird*. Houghton-Mifflin.
Grades 4-6.

Homer, The Iliad and The Odyssey of Homer, retold by Alfred J. Church, Macmillan, 1967.
Grades 4 - 6.

——— The Odyssey of Homer, retold by Barbara Leoni Picard, Walck,
Grades 8 - up.

Hunter, Mollie, The Kelpie's Pearls, Harper & Row, 1975.

——— A Stranger Came Ashore, Harper & Row, 1975. 4-6.
Grades 4 - up.

Jansson, Tove, Moominpappa at Sea, Walck, 1967.
Grades 4 - 7.

Kipling, Rudyard. Captains Courageous. Airmont, 1964.
Grades 6 - up.

Kohn, Bernice. Armistad Mutiny, Dutton, 1971.
Grades 5 - 9.

——— All Kinds of Seals, Random House, 1961.
Grades 1 - 6.

——— The Beachcomber's Book, Viking, 1971 (paper).
Grades 4 - up.

Kumin, Maxine. The Beach Before Breakfast, Putman, 1964.
Grades 2 - 4.

Latham, Jean Lee. Carry on Mr. Bowditch, Houghton-Mifflin, 1955 (paper).
Grades 6 - up.

L'Engle, Madeline, Arm of The Starfish.

L'Engle. Dragons in The Waters. N.Y. FS46. 1976.
Grades 4 - 7.

LeGuin, Ursula K., The Wizard of Earthsea, Bantam, 1975, (paper).
Grades 5 - up.

———The Farthest Shore, Bantam, 1972, (paper).
Grades 5 - up.

Lewis, C.S., Voyage of The Dawn Treader.

Lionni, Leo. Fish is Fish N.Y.: Partheon Books, 1970.
Kindergarten - 2.

Lofting, Hugh, The Voyage of Dr. Doolittle, Dell, 1975.
Grades 1 - 4.

———The Voyages of Dr. Doolittle, Lippincott, 1922.
Grades 4 - 6.

London, Jack, Sea Wolf, Bantam.
Grades 6 - up.

McCaffrey, Anne. Dragonsong, Atheneum, 1976.
Grades 6 - 8.

——— Dragonsinger, Atheneum, 1977.
Grades 6 - 8.

McCloskey, Robert, One Morning in Maine, Viking, 1952.
Grades K - 3.

——— Burt Dow: Deep Water Man. Viking, 1963.
Grades 4 - 6.

——— Time of Wonder, Viking, 1957.
Grades K - 3.

Macdonald, Golden. (pseud. for M.W. Brown), The Little Island,
Doubleday, 1944.
Grades K - 3.

Ness, Evaline. Sam, Bangs, and Moonshine, Holt, 1966.
Grades K - 4.

O'Dell, Scott. Black Pearl, Houghton-Mifflin, 1967.
Grades 7 - up.

——— The Cruise of the Arctic Star, Boston. Houghton-Mifflin, 1973.
Grades 7 - up.

——— Dark Canoe, Houghton-Mifflin, 1968.
Grades 7 - up.

——— Island of the Blue Dolphins, Houghton-Mifflin, 1960.
Grades 4-7.

——— The 290. Houghton-Mifflin, 1976.
Grades 7 - 8.

——— Zia, Boston: Houghton-Mifflin, 1976.
Grades 4 - 8.

Selsam, Millicent. Animals of The Sea, Scholastic, 1976.
Grades K - 3.

——— Around the World with Darwin, Harper Row, 1961.
Grades 2 - 5.

——— Birth of an Island, Harper Row, 1959.
Grades 3 - 6.

——— Under/Water 2005. Morrow, 1961.
Grades 4 - 6.

Sperry Armstrong. Call It Courage, Macmillan, 1940.
Grades 4 - 6.

——— John Paul Jones, Fighting Sailor, Random House, 1953.
Grades 4 - 6.

——— Pacific Islands Speaking, Macmillan, 1955.
Grades 7 - up.

——— Voyages of Christopher Columbus, Random House, 1950.
Grades 4 - 6.

Stevenson, Robert Lewis. Treasure Island, Dutton, 1975.
Grades 6 - up.

——— Kidnapped, New American Library.
Grades 4 - 6.

——— Master of Ballantine Airmont.
Grades 8 - up.

Swift, Jonathan. Gulliver's Travels, Dutton.
Grades 4 - up.

Taylor, Theodore. Battle in the Arctic Seas; N.Y. Crowell, 1976.
Grades 5 - up.

——— Air Raid Pearl Harbor: The Story of December 7, 1941. Crowell, 1971.
Grades 5 - 8.

——— The Cay, Doubleday, 1969.
Grades 4 - up.

——— Teetoncey, Doubleday, 1975.
Grades 4 - up.

——— Teetoncey and Ben O'Neal, Doubleday, 1975.
Grades 4 - up.

——— The Odyssey of Ben O'Neal, Doubleday, 1976.
Grades 4 - up.

Tresselt, Alvin, Follow the Wind, Lothrop, 1950.
Grades K - 3.

——— Hide and Seek Fog, Lothrop, 1965.
Grades K - 3.

——— I Saw the Sea Come In, Lothrop, 1954.
Grades K - 3.

Verne, Jules. 20,000 Leagues Under the Sea, Pendulum Press.
Grades 5 - 10.

——— Around the World in 80 Days, Dodd.
Grades 7 - 9.

Wildsmith, Brian, Fishes, Watts, 1968.
Preschool - up.

Wyss, Johann. Swiss Family Robinson, Dell.
Grades 5 - up.

Yashima, Taro. Seashore Story, Viking, 1967.
Grades K - 3.

Yolen, Jane. Greyling, Collins-World, 1968.
Grades K - 3.

Zolotow, Charlotte. The Storm Book, Harper-Row, 1952.
Grades K - 3.

BIBLIOGRAPHY OF JUVENILE INFORMATION BOOKS OF THE SEA

CHILDREN'S LITERATURE
OF THE
SEA
TEXAS A&M UNIVERSITY

Norma Bagnall
Department of English
Texas A&M University
College Station, TX 77843

September, 1978

Adler, Irving and Ruth Adler, *Oceans*. New York: John Day Co., 1962.
Subject: Oceans

Armour, Richard W., *Sea Full of Whales*. illus. Paul Galdone, New York: McGraw Hill, 1974.
Subject: Whales, dolphins, and porpoises.

Arnold, Oren, *Marvels of the Sea and Shore*. illus. J. Yunge-Bateman, London & NY: Abelard-Schuman, 1963.
Subject: Oceanography

Arnov, Boris, *Bally, The Blue Whale, Life story of the largest living mammal* illus. John Mack, New York: Criterion, 1964.
Subject: Whales

——— *Oceans of the World*. Indianapolis: Bobbs-Merrill, 1962.
Subject: Oceans

——— and Helen Mather-Smith Mindlin, Illus. Charles Mather-Smith, *Wonders of the Deep Sea*. New York: Dodd, Mead, 1959.
Subject: Oceans

Asimov, Isaac, *ABC's of the Ocean*. New York: Walker, 1970.
Subject: Oceans

Bailey, John Swarthwout, *The Wonderful Dolphins*. New York: Hawthorne Books, 1965.
Subject: Dolphins

Banning, George Hugh, *Sailor Ways*. illus. F. I. Siegl, New York: T. Nelson & Sons, 1935.
Subject: Seafaring Life

Barker, Roland, *Windjammer Boy*. Illus. Charles Rosner, New York: J. F. Winters, 1939.
Subject: Seafaring Life

Barlowe, Sy, *Oceans*. Chicago: Follett, 1969.
Subject: Oceans

Bartlett, Mary Raker, *Down to the Sea*. Portland, Oregon: Portland Public Schools, 1953.
Subject: Seafaring Life

Bate, Norman, *What a Wonderful Machine is the Submarine*. New York: Scribner, 1961.
Subject: Submarine Boats

Beaty, John Yocum, *The Ocean Book*. Chicago: Beckley-Cardy Co., 1946.
Subject: Marine Biology

Bergaust, Erik, *Colonizing the Sea*. New York: Putnam, 1976.
Subject: Oceanography

——— and William O. Foss, *Oceanographers in Action*. New York: Putnam, 1968.
Subject: Oceanography

Berres, Frances and others, *Submarine Rescue*. Illus. Joseph Maniscalco, San Francisco: Harr Wagner Pub., 1959.
Subject: Submarine Boats

Berrill, Jacquelyh, *Wonders of the Seashore*. New York: Dodd,Mead, 1951.
Subject: Seashore Biology

Berry, James R. *Medicines from the Sea*. New York: Grosset, Dunlap, 1972.
Subject: Marine Biology

Bethers, Ray, *What Happens in the Sea?* London: Macmillan, 1962.
Subject: Oceans

Blassingame, Wyatt, *The First Book of the Seashore*. Illus. Fred New York: Franklin Watts, 1964.
Subject: Seashore Biology

Blough, Glenn Orlando, *Who Lives at the Seashore?* illus. Jeanne Bendick, New York: Whittlesey House, 1962.
Subject: Seashore Biology

Boff, Charles, Boys' Book of the Sea; The Latest Afloat and Beneath The Waters. New York: Dutton, 1938.
Subject: Oceans

Boyer, Robert Ernst, The Story of Oceanography. New York: Harvey House, 1975.
Subject: Oceanography

Brindze, Ruth, All About Sailing the Seven Seas. New York: Random House, 1962.
Subject: Navigation

——The Sea; The Story of the Rich Underwater World. New York: Harcourt, Brace, Jovanovich, 1971.
Subject: Marine Resources

Bronson, Wilfrid Swancourt, Children of the Sea. New York: Harcourt, Brace, Jovanovich, 1940.
Subject: Dolphins

Brown, Ethel Clare, The Green Gate to the Sea. ed. by Jean Broadhurst, New York-Boston: Silver Burdett, 1924.
Subject: Seashore Biology

Brown, Joseph E. The Sea's Harvest: The Story of Aquaculture. New York: Dodd, Mead, 1975.
Subject: Mariculture

Buck, Margaret Waring, Along the Seashore. New York: Abingdon, 1964.
Subject: Seashore Biology

Buehr, Walter, World Beneath the Waves. New York: Norton, 1964.
Subject: Oceanography

Burgess, Thornton Waldo, The Burgess Seashore Book for Children. illus. W. H. Southwick and George Sutton, Boston: Little, Brown, 1929.
Subject: Seashore Biology

Butler, Mrs. Eva L., Along the Shore. New York: The John Day Co.
Subject: Seashore Biology

Caras, Rober A., The Boundary: Land and Sea. ed. by Roger Caras, foreward by Roger Tory Peterson. Richmond VA: Westover, 1972.
Subject: Seashore Biology

Carlisle, Norman V., Riches of the Sea. New York: Sterling, 1970.
Subject: Oceanography

——— and Madelyn Carlisle. About Submarines. illus. by Roger Herrington. Chicago: Melmont Publishers, 1969.
Subject: Submarine Boats

Carr, Marion Bergner, The Golden Picture Book of Sea and Shore, illus. by Sy Barlowe. New York: Golden Press, 1959.
Subject: Marine Biology

Carse, Robert, Ports of Call. New York: Scribner, 1967.
Subject: Seafaring Life

Carson, Rachel. The Sea Around Us. adapted by Anne Terry White. New York: Simon and Schuster, 1958.

Carter, Katherine (Jones), illus. Mary Gehr, The True Book of Oceans. Chicago: Children's Press, 1958.
Subject: Oceans

Carter, Samuel, The Happy Dolphins. New York: Putnam, 1971.
Subject: Dolphins

Chapin, Henry, The Remarkable Dolphin and What Makes Him So. illus. Richard D. Rice. New York: W. R. Scott, 1952.
Subject: Dolphins

Chase, Mary Ellen, Sailing the Seven Seas. illus. John O'Hara. Cosgrove, Ill. Boston: Houghton, Mifflin Co., 1958.
Subject: Seafaring Life

Cheney, Cora and Ben Partridge, Underseas: The Challenge of the Deep Frontier. New York: Coward-McCann, 1961.
Subjects: Oceanography, Diving, and Submarines

Chester, Michael, Deep-Sea Dive, illus. Charles Gehm, New York: Grosset and Dunlap, 1972.
Subject: Manned Undersea Research Stations

——— and Thomas Chester. Submersibles and Undersea Labs of the World. New York: Grosset and Dunlap, 1970.
Subject: Oceanographic Submersibles

Clarke, Arthur Charles and Mile Wilson, Indian Ocean Treasures. New York: Harper and Row, 1964.
Subject: Diving, Submarines

Clarke, William D., *The Young Pathfinders Book of Oceanss, Streams and Glaciers*. ed. David Halfen, illus. Hilda Simon. New York: Hart Publishing, 1961.
Subject: Oceans

Clemons, Elizabeth, *The Seven Seas*, maps and charts by Cal Sacks, New York: Knopf, 1971.
Subject: Oceans

_____ *Tide Pools and Beaches*, illus. Joe Gault, New York: Knopf, 1964.
Subject: Seashore Biology

Cook, James Gordon, *Exploring Under The Sea*. drawings by Leslie Haywood. London, NY: Abelard-Schuman, 1964.
Subject: Submarine Boats

Coggins, Jack, *Hydrospace: Frontier Beneath the Sea*. New York: Dodd, Mead, 1966.
Subject: Oceanography

Cooke, David Coxe, *How Atomic Submarines Are Made*. New York: Dodd, Mead, 1967.
Subject: Atomic Submarines

Cosgrove, John O'Hara, *Clipper Ship: America's Famous and Fast Sailing Queens of the Sea*. New York: Macmillan, 1963.
Subject: Seafaring Life

Creative Educational Society, *Life in the Sea*., by the editors. Mankato, Minn.: 1971.
Subject: Marine Biology

Cropp, Ben, *Cheeky, the Dolphin*. Adelaide: Rigby, 1968.
Subject: Dolphins

Dadin, Michael, *Submarines*. Chicago: Rand-McNally, 1963.
Subject: Submarine Boats

Daly, Kathleen N., *A Little Golden Book About the Seashore*, illus. by Tibor Gergely. New York: Simon and Schuster, 1957.
Subject: Seashores

Daniell, Albert Scott, *Underwater Exploration*, by [pseudonym] Richard Bowood, illus. B. Knoght. Loughborounh: Wills and Hepworth, 1967.
Subject: Underwater Exploration

Davidson, Margaret, *Nine True Dolphin Stories*, illus. Roger Wilson. New York: Hastings House, 1974. [also Scholastic]
Subject: Dolphins

Dean, Anabel, *Exploring and Understanding Oceanography*. Weschester, Ill.: Benefic Press, 1970.
Subject: Oceanography

Dean, Anabel, *Men Under the Sea*. Illus by Vincent Colabella. New York: Harvey House, 1972.
Subject: Underwater Exploration

———*Submerge! The Story of Divers and Their Crafts*. Philadelphia: Westminster Press, 1976.
Subject: Oceanographic Submersibles - History

Dempsey, Michael W., *By The Sea*, ed. M. W. Dempsey and Angela Sheehan, New York: World Publishing, 1970.
Subject: Seashore Biology

DeNarvaez, Cynthia, *My Dear Dolphin*. photos by Jerry Greenberg, New York: American Heritage, 1969.
Subject: Dolphins

Dukert, Joseph M., *Nuclear Ships of the World*. New York: Coward, McCann, 1973.
Subject: Atomic Submarines

Duncan, Fred B., *Deepwater Family*. New York: Pantheon Books, 1969.
Subject: Seafaring Life

Eckert, Allan, *In Search of a Whale*. illus. Joseph Cellini, Garden City, NY: Doubleday, 1970.
Subject: Whales

Epstein, Samuel, and Beryl Epstein, *The First Book of the Oceans*. New York: Franklin Watts, 1961.
Subject: Oceanography

Educational Research Council of America, *Explorers and Discoverers: Cousteau*. Boston: Allyn & Bacon, 1970.
Subject: Underwater Exploration

Ewart, William Dunlop, *Atomic Submarines*. drawings by K. M. Sibley, London: Weidenfeld and Nicolson, 1963.
Subject: Submarine Boats

Fenten, D. X., *Harvesting the Sea*. Philadelphia: Lippincott, 1970.
Subject: Marine Resources

Fenton, Carroll Lane, *Wild Folk at the Seashore*. New York: J. Day, 1959.
Subject: Seashore Biology

_____and Mildred Adams Fenton, *In Prehistoric Seas*. Garden City, NY: Doubleday, 1963.
Subject: Marine Biology

Field, Adelaide, *The Challenge of the Seafloor*. Boston: Houghton, Mifflin, 1970.
Subject: Submarine Boats

Fisher, James, The Wonderful World of the Sea. London: MacDonald, 1970.
(republishing of 1956 - Adventure of the Sea).
Subject: Marine Biology

Freeman, Mae Blacker, Undersea Base. illus. John Mardon, New York:
Franklin Watts, 1974.
Subject: Manned Undersea Research Stations

Freuchen, Peter, and David Loth, Peter Freuchen's Story About Treasures
of the Seven Seas, Illus. Jules Gotlieb, New York: Messner, 1959.
Subject: Marine Resources

Gaskell, Thomas Frohock, World Beneath the Oceans. with paintings by
Berry Evans, Garden City, NY: published for the American Museum
of Natural History by the Natural History Press, 1964. (also
London: Aldus Books, 1964.)
Subject: Oceanography

Gendron, Val and David A. McGill, Whales. illus. Bill Barss, Chicago:
Follett Publishing, 1965.
Subject: Whales

George, Jean Craighead, Spring Comes to the Ocean. illus. John Wilson,
New York: Crowell, 1965.
Subject: Marine Biology

Goldin, Augusta R., and Felix Sutton, The Illustrated Book of the Sea.
illus. Paul Galdone, New York: Crowell, 1968.
Subject: Marine Biology

Goudey, Alice E., Here Come the Dolphins! illus. Garry Mackenzie,
New York: Scribner, 1961.
Subject: Dolphins

——Here Come the Whales! illus. Garry MacKenzie, New York: Scribner, 1956.
Subject: Whales

Guberlet, Muriel Lewin, The Seashore Parade. illus. Jan Ogden, Lancaster, Pa.: The Jacques Cattell Press, 1942.
Subject: Seashore Biology

Hamilton, Lee David, Let's Go Aboard An Atomic Submarine. illus.
Robert Bartran, New York: Putnam, 1965.
Subject: Atomic Submarines

Hammond, Rolt, Diving and Salbage. London: Muller, 1964.
Subject: Diving, Submarine

Harris-Warren, H. B., Dive! The Story of an Atomic Submarine. New
York: Harper and Row, 1960.
Subject: Atomic Submarines

Hausman, Leon Augustus and Felix Sutton, *The Illustrated Book of the Sea*. illus. Art Renshaw and Herman Bischoff, New York: Grosset and Dunlap, 1957.
Subject: Marine Biology

Heather, Basil, *The Sea Dreamers*. illus. Raymond Burns, New York: Farrar, Struas and Giroux, 1968.
Subject: Seafaring Life

Hellman, Harold, *Navigation: Land, Sea, and Sky*. illus. Erwin Schachner, Englewood Cliffs, NJ: Prentice-Hall, 1966.
Subject: Navigation

Henderson, Daniel MacIntyre, *Children of the Tide*. New York: D. Appleton, 1926.
Subject: Seashore Biology

Hinton, Sam, *Exploring Under the Sea*. illus. Rudolf Freund, Garden City, NY: Garden City Books, 1957.
Subject: Marine Biology

Hoban, Russell, *The Atomic Submarine, A Practice Combat Patrol Under the Sea*. New York: Harper, 1960.
Subject: Atomic Submarines

Hogben, Bernard, *Science and The Navigator*. illus. Kiff, Leicester: Brockhampton Press, 1964.
Subject: Navigation

Holsaert, Eunice and Faith Holsaert, *Ocean Wonders*. illus. Leonard Kessler, NY: Holt, Rinehart and Winston, 1965.
Subject: Oceans

Hornby, John, Undersea World. London: Macmillan; NY: St. Martin's Press, 1960.
Subject: Oceanography

Hunt, Bernice Kohn, *The Beachcomber's Book*. illus. Arabelle Wheatley, NY: Viking, 1970. (also cataloged under Bernice Kohn.)
Subject: Seashore Biology

Huntington, Harriet E. *Let's Go to the Seashore*, photographs, New York: Doubleday, 1941.
Subject: Seashore Biology

Hurd, Edith (Thatcher), *The Mother Whale*. illus. Clement Hurd, Boston: Little, Brown, 1973.
Subject: Whales

Hutchins, Ross E., *The Saga of Pelorus Jack*, illus. Jerome P. Connolly, Chicago: Rand McNally, 1971.
Subject: Dolphins

Hutchinson, William M., *A Maxton Book about The Sea and Its Mysteries*. New York: Maxton Publishers, 1958.
Subject: Oceans

Hyde, Wayne, *What Does a Diver Do?* New York: Dodd, Mead, 1961.
Subject: Diving, Submarines

Icenhower, Joseph Bryan, *The First Book of Submarine Pictures*. New York: Franklin Watts, 1957. (rev. ed. 1970 *Submarines*).
Subject: Submarine Boats

Jackson, Carry Paul, *Seashore-Sheshore Creatures*. illus. Frank Aloise, New York: Putnam, 1964.
Subject: Seashore Biology

Jacobs, Lou, *Duncan the Dolphin.* Chicago: Follett, 1966.
Subject: Dolphins

Jimenez-Landi, Antonio, *A First Look at the Sea*. New York: Franklin Watts, 1961.
Subject: Oceans

Johnson, Robert Lynn, illus. June Talarczyk, *Men Who Work and Explore Under the Sea*. Minneapolis, T. S. Denison, 1968.
Subject: Oceanography

Johnston, Johanna, *Whale's Way*. illus. Leonard Weisgard, Garden City, New York: Doubleday, 1965.
Subject: Whales

Kay, Helen (pseud.) *The Secrets of the Dolphin*. New York: Macmillan, 1964.
Subject: Dolphins

Kingsley, Charles, *Glaucus, or The Wonders of the Shore*. London: MacMillan Co., 1879.
Subject: Seashore Biology

Kirkland, Wallace, *A Walk By the Seashore*. Chicago: Reilly and Lee, 1971.
Subject: Seashore Biology

Knight, David C., *Let's Find Out About the Ocean*. illus. Reni Martin, New York: Franklin Watts, 1970.
Subject: Oceans

Knight, Frank, *Stories of Famous Sea Adventures*, illus by Will Nickless. Edinburgh, London: Oliver and Boyd, 1966.
Subject: Seafaring Life

Koralik, Vladimir and Nada Koralik, *Undersea World of Tomorrow*, illus. George Solonevich, Englewood Cliffs, NJ: Prentice-Hall, 1969.
Subject: Marine Resources

Lane, Ferdinand C., *All About the Sea*. illus. Rudolf Freund, Garden City, NY: Random House, 1953.

Lauber, Patricia, The Friendly Dolphins. New York: Random House, 1963.
Subject: Dolphins

Lent, Henry Bolles, Submarines: The Story of Basic Training at the Navy's Famed Submarine School. New York: Macmillan, 1962.
Subject: Submarine Boats

Leyland, Eric, Boy's Book of the Seas. New York: Roy Publishers, 1959.
Subject: Seafaring Life.

Life (Chicago), The Sea; the Strange Animals and Plants of the Oceans. by the editorial staff of Life and Lincoln Barnett, text adapted by Emma Gelders Stone and Barbara Lindsay. New York (?), 1958.
Subject: Marine Biology

Limburg, Peter R. and James B. Sweeney, 102 Questions and Answers About the Sea. maps and diagrams by William Jaber. New York: J. Messner, 1975.
Subject: Oceanography

Lindquist, Willia, The Golden Stamp Book of Boats and Ships. pictures by Robert Doremus. New York: Simon and Schuster, 1956.
Subject: Navigation

List, Ilka Katherine, Questions and Answers About Seashore Life. woodcuts by author, and illustrated by Arabelle Wheatley, New York: Four Winds Press, 1970.
Subject: Seashore Biology

Lubell, Winifred and Cecil Lubell, By The Seashore. New York: Parent's Magazine Press, 1973.
Subject: Seashore Biology

Maidoff, Ilka List, Let's Explore the Shore. New York: I. Obolensky, 1972.
Subject: Seashore Biology

May, Julian, Captain Cousteau, Underwater Explorer. illus. Phero Thomas, Mankato, Minn: Creative Educational Society, 1972.
Subject: Jacques Yves Costeau

———The Land Beneath the Sea. Illus. Leonard Everett, New York: Holiday House, 1975.
Subject: Oceanography

———There's Adventure in Marine Science. illus. Richard Potts. Chicago: Popular Mechanics Press, 1959.
Subject: Oceanography

McClung, Robert M., Treasures in theSea. Washington: National Georgaphic Society, 1972.
Subject: Marine Biology

McCoy, Joseph J., A Sea of Troubles. illus. Richard Richard Cuffari. New York: Seabury Press, 1975.
Subject: Marine Resources

Meyer, Jerome Sydney, *Picture Book of the Sea*. illus. Richard Floethe, New York: Lothrop, Lee and Shepard, 1956.
Subject: Oceans

Michelson, David Reuben, *The Oceans in Tomorrow's World: How Can We Use and Protect Them?* New York: J. Messner, 1972.
Subject: Marine Resources

Milne, Lorus Johnson, and Margery Milne, *When the Tide Goes Far Out*. illus. Kenneth Gosner, New York: Atheneum, 1970.
Subject: Seashore Biology

Moffett, Martha L. and Robert Moffett, *Dolphins*. New York: Watts, 1971.
Subject: Dolphins

Moffett, Robert Knight and Martha L. Moffett, *The Whale in Fact and Fiction*. illus. Ralph Pinto. New York: Quist, 1967.
Subject: Whales

Montgomery, Rutherford, *Dolphins as They Are.* New York: Duell, Sloan and Pearce, 1966.
Subject: Dolphins

Morgan, Elizabeth, *In the Deep Blue Sea*. illus. Peter P. Plasencia. Englewood Cliffs, N.J.: Prentice-Hall, 1962.
Subject: Oceans

Morriss, Frank, *Submarine Pioneer, John Philip Holland*. illus. Dirk Gringhuis. Milwaukee: Bruce Publishing, 1961.
Subject: Submarine Boats

Morris, Robert Ada, *Dolphins*. illus. Mamoru Funai, New York: Harper, 1975.
Subject: Dolphins

Nakatani, Chiyoko. *Fumio and The Dolphins*. London: Bodley Head, 1970.
Subject: Dolphins

Neurath, Marie, *The Deep Sea*. New York: Sterling Pub., 1958(?).
Subject: Marine Biology

______ *Exploring Under the Sea*. New York: Lothrop, Lee, 1959.
Subject: Submarine Boats

Nightingale, Charles, Exploiting the Oceans. London: Methuen; New York: Roy Publishers, 1968.
Subject: Marine Resources

Overbeck, Cynthia, *Splash, the Dolphin*. translated from the French of Jean Saint Gen, Minneapolis: Carolhoda Books, 1976.
Subject: Dolphins

Owen, Robert, *Let's Look at the Seashore*, illus. Norman Ost. London: F. Muller, 1964.
Subject: Seashores

Parker, Bertha Morris, *Animals of the Seashore*. New York: Row, Peterson
and Co., 1942.
Subject: Seashore Biology

Patch, Edith Marion and Carroll Lane Fenton, *Holiday Shore*. New York:
Macmillan, 1935.
Subject: Seashore Biology

Perry, John and Jane G. Perry, *Exploring the Seacoast*. New York:
Whillesey House, 1961.
Subject: Seashore Biology

Phelger, Fred B., *The Whales Go By*. illus. Paul Galdone. New York:
Beginner Books, Random House, 1969.
Subject: Whales

Pilkington, Roger, *How Ships Are Navigated*. London: Routledge and Paul,
1962.
Subject: Navigation

Pizer, Vernon, *The World Ocean; Man's Last Frontier*. drawings by Lewis
Zacks. Cleveland: World Pub. 1967.
Subject: Oceanography

Podendorf, Illa, *The True Book of Animals of the Sea and Shore*. illus.
Chauncey Maltman. Chicago: Children's Press, 1956.
Subject: Marine Biology

Posin, Daniel Q., *Man and the Sea*. illus. David Burnside, Chicago:
Lyons and Carnabar, 1963.
Subject: Oceans

Posell, Elsa V., *The True Book of Whales and Other Sea Mammals*. illus.
Arthur Warheit, Chicago: Children's Press, 1963.
Subject: Whales

Ray, Carleton, *Wonders of the Living Sea*. illus. Oscar Liebman, New
York: Home Library Press, 1963.
Subject: Oceanography

Read, Richard, *The Living Sea*. illus. Prudence Theobaldo Hammondsworth,
England, Baltimore: Puffin Books, 1974.
Subject: Marine Biology

Robinson, William Wilcox, *At The Seashore*. illus. Irene Robinson,
Los Angeles: Ward Ritchie Press, 1964.
Subject: Seashores

Rood, Ronald N., *The Sea and Its Wonderful Creatures*. illus. G. Don
Ray. Racine, Wisc.: Whitman, 1965.
Subject: Marine Biology

Ryan, Peter, *The Ocean World*. illus. Ludek Pesek. Harmonsworth & Baltimore: Penguin Books, 1973.
Subject: Oceanography

Sauer, Peter, *Seashell Towns*. illus. Mark A. Dinn, New York: Coward-McCann, 1968.
Subject: Seashore Biology

Scharff, Robert, *The How and Why Wonder Book of Oceanography* . illus. Robert Doremus. New York: Wonder Books, 1964.
Subject: Oceanography

Selsam, Millicent, *See Along the Shore*. illus. Leonard Weisgard, New York: Harper, 1961.
Subject: Seashores

Shannon, Terry and Charles Payzant, *Windows in the Sea: New Vehicles That Scan the Ocean Depths*. Chicago: Children's Press, 1973.
Subject: Underwater Exploration

Shepherd, Elizabeth, *Tracks Between the Tides*. illus Anabelle Wheatley. New York: Lothrop, Lee and Shepard, 1972.
Subject: Seashore Biology

Sherman, Diane Finn, *You and the Oceans.* illus. Bill Sanders, Chicago: Children's Press, 1965.
Subject: Oceanography

Silverberg, Robert, *The World of the Ocean Depths*. New York: Meredith Press, 1968.
Subject: Marine Biology

Simon, Seymour, *From Shore to Ocean Floor: How Life Survives in the Sea*. illus. Haris Petie, New York: Watts, 1973.
Subject: Marine Biology

Simon, Mina Lewiton, *Is Anyone Here*? illus. Howard Simon. New York: Atheneum, 1967.
Subject: Seashore Biology

Sloan, Tay, *Wonders of the Pacific Shore*. Chicago: Children's Press, 1961.
Subject: Seashore Biology

Sobol, Donald J., True Sea Adventures. Nashville: T. Nelson, 1975.
Subject: Seafaring Life

Solem, George Alan, *Life Along the Seashore*. Chicago: Encyl. Britannica Press, 1963.
Subject: Seashore Biology

Soule, Gardner, *New Discoveries In Oceanography.* New York: Putnam, 1975
Subject: Oceanography

Spilhaus, Athelstan Frederick, *The Ocean Laboratory*. Mankato, Minn: Creative Educational Society, 1967.
Subject: Oceanography

Steele, George P., *Vengence In The Depths*; The Nuclear Submarine. New York: E. P. Dutton, 1963.
Subject: Atomic Submarines

——— and Herbert J. Gimpel, *Nuclear Submarine Skippers and WhatThey Do*. New York: F. Watts, 1962.
Subject: Atomic Submarines

Stephens, Edward Carl, *Submarines: The Story of Underwater Craft From the Diving Bell of 300 B.C. to Nuclear Powered Ships*. illus. Jack Coggins, New York: Golden Press, 1962.
Subject: Submarine Boats

Stephens, William M., *Come With Me to the Edge of the Sea*. New York: Messner, 1972.
Subject: Seashore Biology

——— *A Day in the Life of a Sandy Beach*. illus. Mel Greifinger. New York: McGraw-Hill, 1973.
Subject: Seashore Biology

——— *Life in the Open Sea*. illus. Rene Martin, New York: McGraw-Hill, 1972.
Subject: Marine Biology

——— *Science Beneath the Sea: The Story of Oceanography*. New York: Putnam, 1966.
Subject: Oceanography

Stratton, Leonard Walter, *Your Book of the Seashore*. London: Faber, 1970.
Subject: Seashore Biology

Telfer, Dorothy W., *Exploring the Wrold of Oceanography*. Chicago: Children's Press, 1968.
Subject: Oceanography

Thompson, George Pirie, *Submarines*. illus. K. E. Carter. London: Muller, 1957.
Subject: Submarine Boats

Van Gelder, Richard George, *The Professor and The Vanishing Flags*. illus. Harriett Irvington, Hudson, New York: Harvey House, 1965.
Subject: Whales

Vevers, Henry Gwynne, *Life in the Sea*. illus. Barry Driscoll, New York: McGraw-Hill, 1963.
Subject: Marine Biology

Viemeister, Peter E., *Navigation.* Garden City, New York: Doubleday, 1963.
Subject: Navigation

Vogel, Helen Wolff, and Mary Leonard Caruso, Ocean Harvest; the Future of Oceanography. illus. John Kaufman, New York: Knopf, 1961.
Subject: Oceanography

Waddell, Helen J., When the Tide Goes Out. Cleveland: World Publishing Co., 1969.
Subject: Seashore Biology

Wakeman, Norman Hammond, Wonders of the World Between the Tides. New York: Dodd, Mead, 1961.
Subject: Seashore Biology

Watson, Jane Werner, Whales: Friendly Dolphins and Mighty Giants of the Sea. illus. Richard Amundsen. New York: Golden Press, 1975.
Subject: Whales

Weller, George Anthony, The Story of Submarines. New York: Random House, 1962.
Subject: Submarine Boats

Wheat, G. Collins, Whales and Dolphins . . . illus. Helmuth Wagner, New York: Golden Press, 1963.
Subject: Whales

Williams, Jerome, Oceanography. New York: F. Watts, 1972.
Subject: Oceanography

Williams-Ellis, Anabel, The Unknown Ocean. illus. Robert Eggero. New York: Putnam, 1959.
Subject: Oceanography

Wyckoff, James, Who Really Invented the Submarine? New York: Putnam, 1965.
Subject: Submarine Boats

Yerian, Cameron John, ABC's of Hydrospace. illus. Jim Gindraux. Los Angeles: Elk Grove Press 1971.
Subject: Oceanography

Young, Edward Preston, Look at Submarines. illus. John Robinson. London: H. Hamilton, 1964.
Subject: Submarine Boats

Young, Jim, When the Whales Came to My Town. photos. Dan Bernstein, New York: Knopf, 1974.
Subject: Whales

COMMERCE AND THE INTERTIDAL BEACHES

TEACHER BACKGROUND - Commerce and the Intertidal Beaches

"Commerce and the Intertidal Beaches" is the first of several activities dealing with people and the shoreline. The lesson serves as an introduction to the curriculum and as an overview of what will be investigated in the coming weeks.

Now is the time to preview the other topics in the guide. Become familiar with the organization of this guide. Each major division (for example, "Commerce and the Intertidal Beaches") has an introductory reading which sets the background for that section. The reading includes text questions for your students to answer as they read. The major divisions also include student activities and laboratory exercises. Each activity or exercise has a separate "Teacher Background" section. The "Teacher Background" section provides you with information related to the activity or reading, answers to the questions asked in the text, and a "Key Words" section which contains those words likely to be unfamiliar to your students.

Start this lesson with enthusiasm - it's contagious. Provide your students with ample pictoral aids. If you have a marine aquarium begin to relate the marine environment in its natural state to the artificial marine environment in the aquarium. Maps and globes will help your students locate the world ocean, its major ports, and those ports nearest you.

When you discuss the careers related to the intertidal zone, be sure to mention those that will be covered in more depth later. This lesson should be viewed as an introduction. Greater development of the ideas mentioned will occur later.

Duplicate the text pages. One set is recommended per student. Note that the text questions immediately follow the section to which they pertain. This approach serves to reinforce and/or expand the topic in the most logical fashion. The "Key Words" should be taught if they are unfamiliar to your students. With few exceptions, the "Key Words" are either defined directly in the text, or are defined by context. The activities presented are designed to reinforce the concepts introduced. The reading level of the text is such that fourth graders should be able to read the material with little difficulty. Some students will undoubtedly need more assistance than others. You may also elect to read the work orally to your class. Either way, plan to allow time for a class discussion of the materials.

KEY

1.,2. These questions are provided to start your students thinking about the commercial life of the intertidal beaches. Occupations range from tug-boat captains to bait shop owners to fishers (a term gaining use over the more traditional "fisherman"). Encourage discussion of the variety of occupations available within the intertidal beaches.

3. a. Three pieces of gear needed by SCUBA divers and shown in the picture include: mask, snorkel, air tube, depth gauge, waterproof watch, wet suit, weight belt, knife, flippers, and air supply.

   b. A sporting goods store is the most likely spot to purchase SCUBA gear.

4. Again, this question provides an opportunity for your students to think about the occupations involved in getting a salmon from the ocean to the plate.

5. Additional occupations involved in bringing you a salmon dinner might include: chef, waiter, homemaker, truck driver, refrigeration salesman, refrigeration repairman, etc. The specific jobs are not important. In your discussions stress the relationships between jobs and how workers are dependent upon each other for their livelihood.

KEY WORDS - (words which may be unfamiliar to your students)

area
beach
careers
clams
commerce
commercial
crabs
crew
equipment
fisherman
harvested
interrelated
intertidal beaches
occupations
oysters
recreational
related
salmon
shellfish
shrimp
scuba
snorkel
tackle
tide

ANOTHER VIEW...

The following article by Hal Goodwing appeared in CURRENT/the Journal of Marine Education (1981, Vol. 2, No. 4). It presents a realistic picture of how people make a living in the world of water. Read this article to obtain the perspective necessary when teaching the activities included in Marine Science Career Awareness - Grade 4.

At Work in the World of Water

by Harold L. Goodwin

Of all the poets who have written about the sea, it seems probable that Rudyard Kipling understood it best. One of his shorter verses is titled "Mary's Son" and, in it, Mary Gloster gives some advice to her Willy:

> If you stop to find out what your wages will be,
> Or how they will clothe and feed you,
> Willy, my son, don't go on the sea.
> The Sea will never need you.
>
> If you ask the reason for every command
> And argue with people about you,
> Willy, my son, better stay on the land.
> The Sea will do better without you.

Conditions for those who go to sea, and their pay, have improved immeasurably since Kipling wrote those lines, but there is still the ring of truth to them. In more modern times, one of the great men of the sea business, the late Dr. Wilbert Chapman, said this:

> The ocean weeds out from all the races of
> mankind that come upon it to make a living
> a certain type of person. This type of person
> stays with the ocean, and the rest are cast
> back ashore to deal with the land people.

The problem is that the sea itself has to do the weeding. It is very hard to predict who will turn into sea people and who will not—and the desire for money will not be the determinant. There is very little a teacher, parent, or guidance counselor can do about separating the sea people from the land people.

What the guidance counselor can do is provide essential aids to student navigation by presenting a true picture of marine careers and by helping the student to relate those careers to himself or herself.

Step one is the destruction of illusion. Consider what motivates the student toward a sea career: First, there may have been real experiences in the recreation of the sea, in sailing, fishing, diving, swimming or simply beachcombing. What is more natural than to want to continue all that fun as a career? Second, there is visual entertainment in the form of motion pictures or television, epitomized by the undersea world of Jacques Cousteau. Third is the written word, which strongly influences those young people who still read for pleasure.

The sum of these motivators is a series of false images. The young imagination is exposed most of all to images of what purports to be the sea scientist. With few exceptions, what the young person accepts as sea science is hokum. The hokum content may vary from exaggeration for dramatic impact to pure fiction, all presented as fact. When we combine the hokey image with youthful idealism and the concern for life and the environment, the young person may envision a career as a marine scientist saving the oceans from mankind through acts somehow related to diving in clear, warm tropical waters.

In coming to grips with marine careers, it is instructive to begin with employment. Where do people work? This isn't easy to find out. The Bureau of Labor Statistics of the U.S. Labor Department does not maintain marine-related jobs as distinct categories, but lumps most of them with land industries. So the numbers we are about to cite are rough approximations, and it is best to consider them in relation to each other rather than as absolute employment figures.

Marine Science

If we combine under the heading of marine science all those occupations requiring a significant degree of scientific education or specialized technical training, we find less than 200,000 people involved. Of these, about 75 percent are in regulatory and environmental jobs—employed principally by federal, state, or local government. Of the remaining 25 percent, perhaps a fifth are in communications, including marine advisory services, and the rest are about evenly divided between educators and researchers.

Let's assume that about 20,000 people are working in research and development marine careers, not including ship crews. This is the category that embraces most of the youthful image. Of those 20,000, the ratio of support personnel to scientists is nine technicians, craftspeople, and other support people to each scientist. Or, a total of 2,000 glamour figures. This is probably too pessimistic an estimate, so let's be wildly optimistic and assume that we have 5,000 glamorous marine scientists at work.

Marine Operations

Then who are all those people who work on the water? Leaving out fishers for the moment, we find them in four broad categories, perhaps 400,000 in number. All together, sea-going merchant mariners of all ranks add up to about 50,000 people. There are as many engaged in offshore support operations for the petroleum and natural gas exploration and recovery industries, not including platform drilling crews. Twice as many work in port and harbor operations. And most, more than three times as many as our merchant mariners, work on the inland waterways of the nation.

Marine Resources

It is true, we need the resources of the sea, and some day an enlightened government—if we ever get one—will make new policies to use our marine resources wisely. But that time is not yet, and what we have today are two kinds of marine resources: seafoods and petroleum. Less than a half million people are at work in U.S. marine resource production, and petroleum exploration and production account for perhaps a hundred thousand in addition to support services. By far the largest employment in marine resources is in fisheries, with perhaps a quarter million fishers and another 150,000 engaged in processing and handling the commercial catch. The glamorous field of aquaculture, to which so many young people are attracted, probably employs less than 10,000 people, and most of those are semi-skilled.

Marine Construction and Technology

There is still a substantial shipbuilding industry in this country, especially if we include construction of offshore platforms and military vessels. We may have nearly three-fourths of a million persons engaged in construction, shipbuilding, and engineering activities in a good year.

Marine Recreation

There are probably close to a million persons engaged in some aspect of the marine recreation industries. Within this category, recreational boat and equipment manufacture accounts for about four-fifths of the employment, and marina and other facility operations—including aquaria of all kinds—account for the other fifth.

Who Goes to Sea?

I've taken estimates made in 1976 and inflated them to account for what seems to be growth in some fields, and the estimates are probably high. At the most wildly optimistic estimate there are less than two and a half million people in marine careers in this nation. Again, being optimistic beyond the point of reality, we estimate that perhaps 600,000 people actually work *on* the water, and of those a quarter million are commercial fishers.

So What is a Marine Career?

In the real world of work, a marine career for most people is simply a marine application of a land skill or land knowledge. There are very few marine careers in which the training or education does not begin with a land base. There are two major exceptions: shipboard operations and commercial fishing. Even for those, land knowledge and skill comes into play very heavily.

The picture I am trying to paint is not a discouraging one. We don't want to turn young people off, but we do want to give them a realistic appraisal, not only of career opportunities, but also of how their own personalities and abilities can fit.

Example: A marine scientist, even a Ph.D. bluewater oceanographer, is very fortunate to spend ten percent of the time at sea.

Example: A high percentage of young people are attracted to marine biology. The result: we have turned out so many biologists at all levels from baccalaureate to Ph.D. that graduates cannot find employment. There are so many marine biologists with M.S. and Ph.D. degrees looking for jobs that employers often hire a Ph.D. as a biological technician at low wages.

Example: In visiting marine technician courses—vocational education courses, that is—I've met Ph.D.'s and M.S.'s who were taking the courses. The reason? They found out, after their educations to graduate level were over, that they didn't want to be scientists. They were people who wanted to be out-of-doors, who enjoyed working with their hands, who disliked paperwork, who couldn't contend effectively with the politics of academia. One could say that the higher education didn't hurt them any, but it certainly lost them time and, at today's rate for graduate degrees, put them in an economic hole. How much better off those people would have been had a wise counselor asked these questions: What do you really like to do? What kind of person are you? How curious are you about the world around you? Have you though very much about what you want out of life?

Career Rewards—Financial

By holding a college education as the first major goal of so many, we have produced serious cultural change. I believe this emphasis has been an important reason for the erosion of what we used to call the "dignity of labor." The term "blue-collar worker" is a pejorative, connoting someone inferior to the educated white-collar worker.

Again, the image is far from the reality. Show me a master welder who can weld the seam on a titanium pressure vessel for use in the depths of the sea and I'll show you a person whose annual income exceeds that of the most senior marine scientist in any academic institution in the country. Show me a real highline fisher on any of our coasts and I'll show you a person whose annual income exceeds that of a United States Senator, even with the recent Congressional raise. The fact is, except at the highest levels of seniority and earned reputation, being a scientist doesn't pay all that well.

The skilled trades pay better. Contrast the image of the scientist diving in warm tropic waters with the reality of commercial diving. The commercial diver is usually in cold water, often in currents so high he has to hold on with one hand or tie himself to the job, and with visibility so low that he's lucky to see a foot beyond his face plate. He makes far more money than the scientist, and he deserves to. To sum up, there are some marine careers called blue collar that pay much better than the great majority of white-collar marine careers, offer more time off, and are at least as much fun.

There are marine careers that pay so little two or more jobs are needed to make ends meet. Many of those in marine recreation are like that, especially for "hands" around a marina or in retail sales. In short, marine careers aren't all that different from land careers when it comes to financial rewards.

What School Shall I Go To?

Assuming some reasonable notion of what the career is and how it relates to the student's desires, the question is: What next? First, how to get an education or necessary training; second, how to get a job.

To dispose of the second question first, for most marine careers there is no way to get a job except those common to all pursuits. Job hunting is the term. The exceptions are union hiring halls, plus some proprietary schools that promise and deliver placement.

The oiler, steward, or deck hand graduating from the Harry Lundeberg School at Piney Point, Maryland, finds a job among those posted in the hiring hall at the Port of Piney Point. The Seafarers International Union gets them started. Some commercial major diving contractors place qualified graduates. Some Sea Grant courses in vocational specialties also have extremely good placement records. On the whole, it's probably easier for a vocational or para-professional graduate to move immediately into a job than it is for a college graduate.

The choice of schools is probably easier for the vocational student. For one thing, there are fewer choices. Essentially, there is a choice between public institutions, often in two-year colleges although more frequently now in high schools, and rather costly proprietary schools.

For students going to college with an eager eye on saltwater, getting to the sea isn't all that easy, even in colleges that are strongly marine-oriented. That's because the curriculum tends to be pretty much the same everywhere for the freshman year. My own view is that it doesn't much matter where the student goes so long as the student knows what to expect and the institution is of the best quality that the student can afford.

I'm very leary of baccalaureate oceanographic courses. The quality of education may be high, but no matter how many qualifiers there are in the language, the student will tend to expect a job on graduation and there aren't that many jobs for oceanographers at that level.

But there are many schools to choose from and most of them are listed in *University Curricula in the Marine Sciences and Related Fields.*

The Uniformed Careers

Don't overlook the U.S. Navy as a career at either enlisted or officer level, especially when pay levels improve. For college students, there's the NROTC on some campuses. The US Coast Guard can be a great career at either officer or enlisted level. And there is a small uniformed service that used to be the US Coast and Geodetic Survey, now the National Ocean Survey, which may be available for a small number of college graduates.

To me, the uniform of the Merchant Marine Officer is a proud one. There are state Maritime Academies in Maine, Massachusetts, New York, Texas, and California, and the Federal Academy at Kings Point, New York.

Of Aspirations and Careers

Roger Revelle listed these needs as most important in choosing a career and living one's life in it:

- First, the need for hope. The possibility that for each individual the future may be better.

- Second, the need for security. Basically, what this means is that the future won't be worse—that people can look forward (in their careers) to a future that is at least no worse than the present.
- Third, the need to participate, the need to have some voice and some control in shaping our own future; all people have this need to participate.
- Fourth, the need to achieve some kind of immortality, some way to make a contribution to the future.

To me, implicit in that fourth point is satisfaction in accomplishment. Maybe it needs to be made explicit in a fifth point: there must be ego satisfaction in a career. The nice thing about a marine career—any marine career—is that the probabilities of such satisfaction are a bit higher than one finds among landlubbers.

The Many Career Choices

The spectrum of marine careers is as broad as one finds on land. The differences are in those careers that really take people to sea. Otherwise the career is apt to be a land career adapted and applied to the necessities of the world of water.

Education in law, for example, is standard up to the point of specialization. Admiralty law has been a specialization since Elizabethan days, and now we have new and different specialties in environmental law and marine international law. The study of economics is pretty much the same everywhere, but the application of economics—or business administration—is an important marine career option. I mention those because we do not yet have enough good marine lawyers of the new type, enough good marine economists, and certainly not enough good business administrators with marine specialties.

I've noted we've exceeded saturation in the production of marine biologists, yet fewer students have gone on to become physical or chemical oceanographers, so there are some jobs in those fields. There are more jobs than graduates in geology these days, a discipline important to the oceans.

We haven't talked much of ocean engineering, but civil, mechanical, chemical, industrial, agricultural, and electrical engineers all can apply their basic skills to the problems of the sea, and we still need naval architects. There is a shortage of the field straw-boss type of engineer, and a few years ago we set up a work-study program to produce supervising engineers at Mississippi State University. It has been a great success and shipbuilding companies hire kids as fast as they graduate with bachelor's degrees.

The greatest employment opportunities, though, are in the trades, and we've noted that the master craftsperson does as well, and in some cases better, than the professional—at least financially. On the whole, the skilled trades are good careers. What's more, because the basic skills can be applied on either land or sea, the craftsperson has greater flexibility. Apart from the construction and shipbuilding industries, there's a whole field of instrumentation manufacture and servicing. And, a good all-around engine mechanic who's willing to go to sea under difficult conditions can make a senior engineer's wages for a year in only about three months. At the lower-paying levels, there is employment in the processing and distribution industries where seafoods are processed and packaged. For those who really want to be on the sea, one of the most ancient and honorable careers is that of the fisher.

The choice is wide. Try to think of a land career for which there is no sea counterpart, one for which there is no marine application. It isn't easy.

References

Abel, Robert B. *Careers in oceanography*. Sea Grant College Program, Texas A&M University, College Station, Texas 77843. TAMU-SG-79-608.

Goodwin, Harold. *Today's youth in tomorrow's sea*. Oregon State University, Extension Marine Advisory Program, Corvallis, Oregon 97331.

Marine Technology Society. *The oceans and you*. 1730 M Street, N.W., Washington, D.C. 20036.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. *University curricula in the marine sciences and related fields: academic years 1979-80, 1980-81*. 6010 Executive Boulevard, Rockville, Maryland 20852.

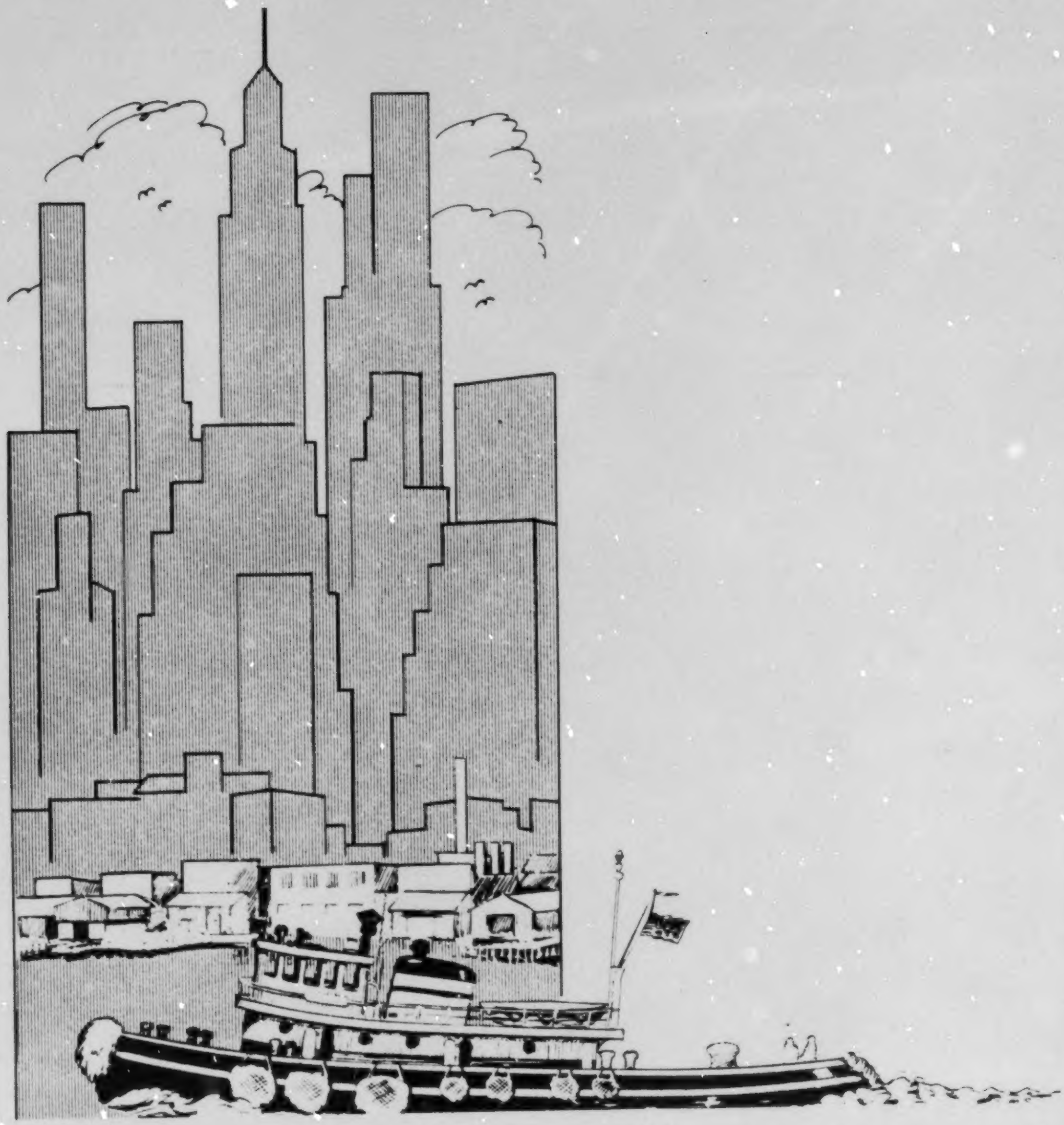
This article is an edited form of *Harold L. Goodwin's* keynote address for the "Careers in the Marine Environment Conference" held at the Wetlands Institute, Cape May County, New Jersey, on October 12, 1979.

COLLEGE STATION, TX—Former Texas senator A. R. "Babe" Schwartz will deliver the Robert Stegner Memorial Lecture during the opening session of the National Marine Education Association meeting in Galveston. Schwartz, who served 20 years in the Texas Senate, will discuss marine education and politics.

Schwartz's involvement with coastal management and related legislation began in the 1950s when he was a member of the Texas House of Representatives. During this time, he was instrumental in guaranteeing the public the right of free access to beaches, and wrote every major piece of coastal legislation introduced while he was a senator. He is a past chairman of the national Coastal States Organization and served as chairman of the Texas Coastal and Marine Council.

COMMERCE AND THE INTERTIDAL BEACHES

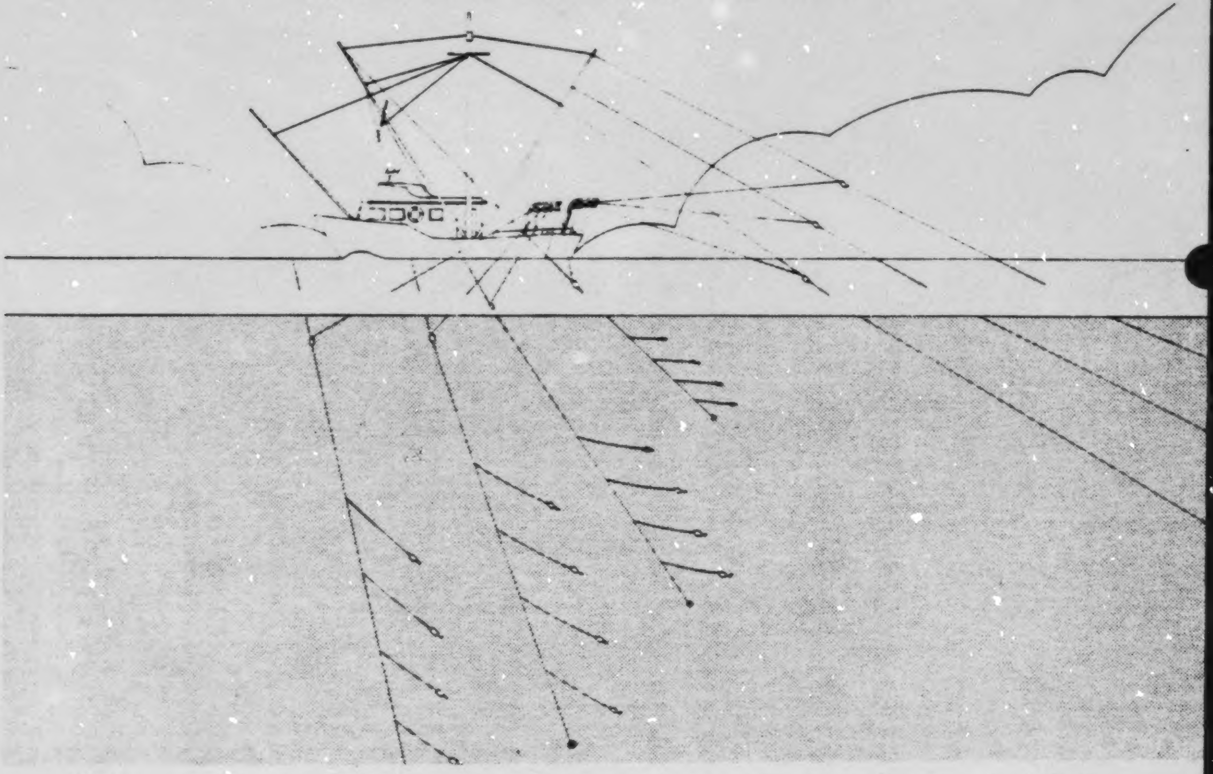
The shores are busy places. Many people work along these intertidal beaches. Water moves up and down the beach with the tide. The water movement affects the people who work along the shore. There are many jobs in the intertidal beach. They range all the way from boat building to fishing. The many different jobs are all inter-related. The jobs depend on each other.



1. What are three jobs you could find related to the intertidal beaches?

a.
b.
c.

Some people work in commercial occupations. Many commercial jobs deal with selling things. People sell goods all the way from fish to boats. Other people work in recreational occupations. Sports fishing and pleasure boating are recreational jobs that look like a lot of fun.

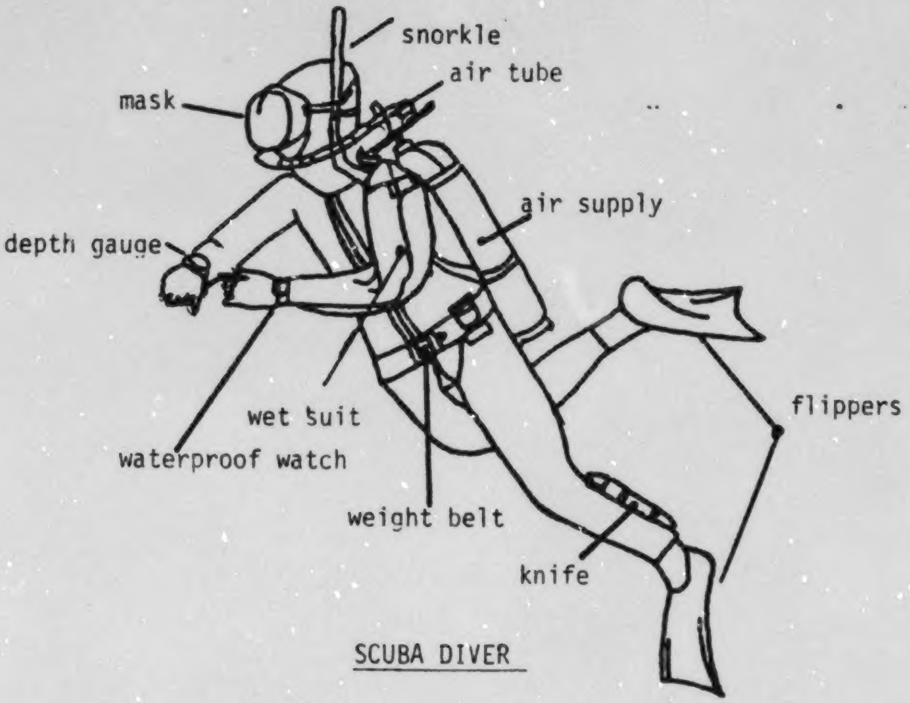


2. What are two commercial jobs and two recreational jobs you might find along the shore?

Commercial jobs: a.
b.
Recreational jobs: a.
b.

There are many recreational careers related to the intertidal area. Sports fishers must be outfitted from a sporting goods store. Think about all the equipment needed: boats, poles, special clothing, fishing baskets, and tackle.

SCUBA diving is done along our shores. What steps are needed to get all the gear to the store? Where does the store get these items? What type of training do you need to be a SCUBA diver?


snorkle
air tube
mask
air supply
depth gauge
flippers
wet suit
waterproof watch
weight belt
knife

SCUBA DIVER

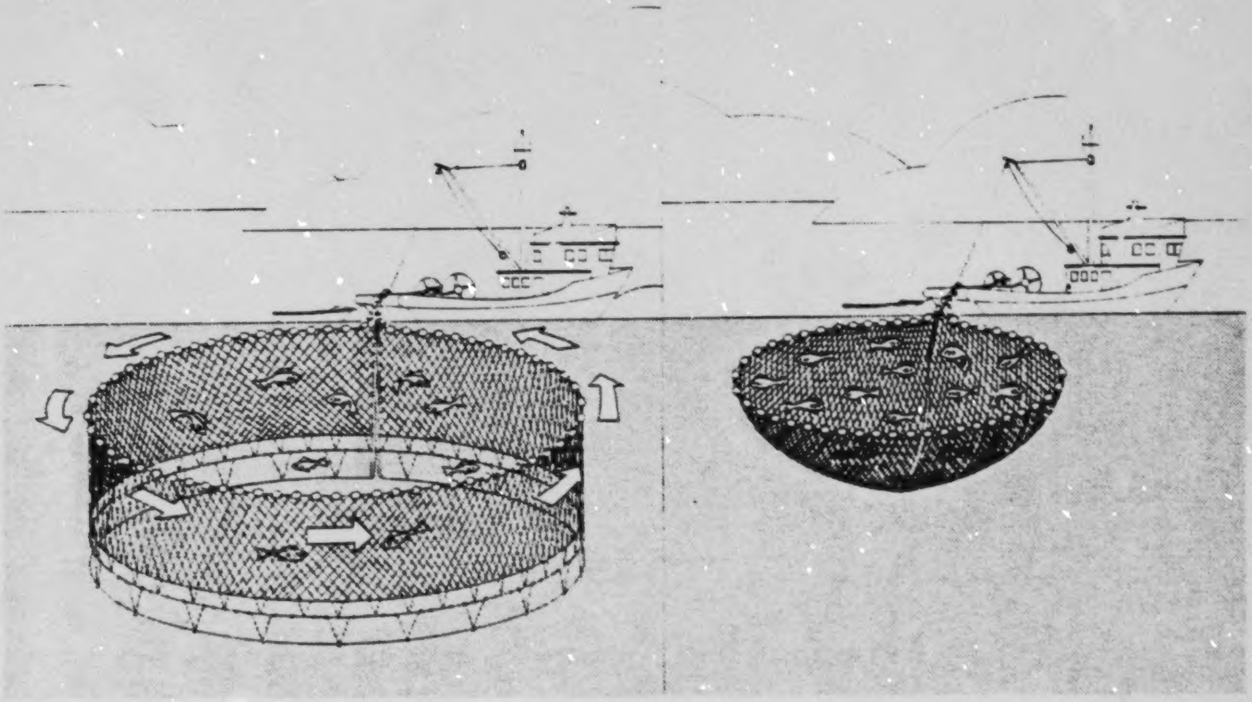
3. Use the picture above to answer the following questions:
   a. What are three pieces of gear needed by a SCUBA diver?

      A.
      B.
      C.

   b. In what kind of store would you buy SCUBA gear?

Fishing, clamming, swimming, beachcombing, water skiing, boating, and diving are all recreational pastimes of the intertidal zones. You may have enjoyed some of these activities.

Think of all the people needed to make these activities possible. People have to get the gear for these activities to the stores. Think of the many hours it took to make each small item. Think of the material needed to make each item. How did the stores find out about the item? How did the item arrive at the sports store? Who unpacks each item in the store? Who prices it? Who sells it so you can enjoy your favorite intertidal recreation? All of these jobs are inter-related. They all depend upon the intertidal zones.



Many commercial occupations depend upon the shoreline. Commercial fishers fish in the waters off the coast. People gather crabs, clams, and oysters. Shrimp are sold off the boats. People raise fish and shellfish at the water's edge.

4. Many people like to eat salmon. Before you can eat, lots of work is involved. Think of two occupations involved in bringing you a salmon dinner. Write them in the spaces below.

a.
b.

Let's think about all the people who work to bring you your salmon dinner. First, we need to design and build the boat. Other people make nets and other gear needed. Someone has to bring the net to the boat. The fisherman has to buy food for his crew. He has to buy gas for his boat. He catches the fish and starts it on its way to you. Once the salmon is harvested, other people clean, freeze, can, and transport the fish. Still other people sell you the fish. All of the jobs are interrelated. They all happen just because you (and people like you) like salmon.

5. Now you know more about salmon dinners. List two additional occupations involved in bringing you a salmon dinner?

a.
b.

Let's look at some of the ways people make a living from the edge of the sea.

TEACHER BACKGROUND - Jobs, Jobs, Jobs!

This is a relatively simple exercise designed to make your students look at the interrelationships that exist between occupations. The jobs are all interrelated in several ways. The actual location of arrows lining the jobs is less important than discovering how the students view the relationships. You can generate an interesting discussion of the many and varied ways these occupations depend on each other.

Provide as much help as the students need in adding three jobs to the list provided. If necessary, you may elicit a list from the entire class and write the list on the board. Individuals may then select three occupations from the new list.

The important activity here is the discussion. Let your discussion be a springboard for the topics to be covered in the days ahead.

KEY

Answers will vary depending upon experience and perspective of class. Encourage discussion of the relationships your students perceive.

KEY WORDS

clam digger
fish
freezer
interrelated
intertidal zone
net
related
restaurant
salesperson
salmon
scuba diver
ski
sporting goods
swimming

JOBS, JOBS, JOBS!

Every job in the intertidal zone is related to other jobs. Below is a list of jobs. DRAW ARROWS BETWEEN ALL OF THE JOBS THAT ARE INTERRELATED. Be sure you can explain how one job relates to the other (for example: fishermen sell their fish to fish sellers).

SPORTING GOODS SALESPERSON

FISH STORE OWNER

SCUBA DIVER

RESTAURANT OWNER

WATER SKI MAKER

TRUCK DRIVER

SWIMMING SUIT MAKER

CLAM DIGGER

NET MAKER

FREEZER REPAIRMAN

GAS STATION OWNER

FISH CLEANER

SALMON FISHERMAN

BOAT MAKER

In the space above write in THREE (3) jobs that are related to the jobs listed. Connect those jobs by arrows to the other jobs listed.

TEACHER BACKGROUND - Transportation

Historically, the use of waterways for travel rivals that of their use in supplying food. From dug out canoes to super tankers, water travel has provided and still provides an effective means of transportation. "Transportation" provides your students with an overview of some of the transportation activities of the intertidal ports.

The activity introduces some concepts such as bouyancy and "Lord Plimsoll's mark" which will appear again in future activities. If you're located near a port, consider contacting the port authority for information regarding tours. Otherwise, you may wish to supplement the activity with audiovisual aids related to ports and transportation.

Duplicate the text pages. One set is recommended per student. This activity may be accomplished by individual students or by small groups working together. Alternatively, it may be assigned as a take home assignment. Which ever approach you choose, be sure to provide time for a discussion of the text questions as a follow-up designed to reinforce the new ideas and concepts introduced.

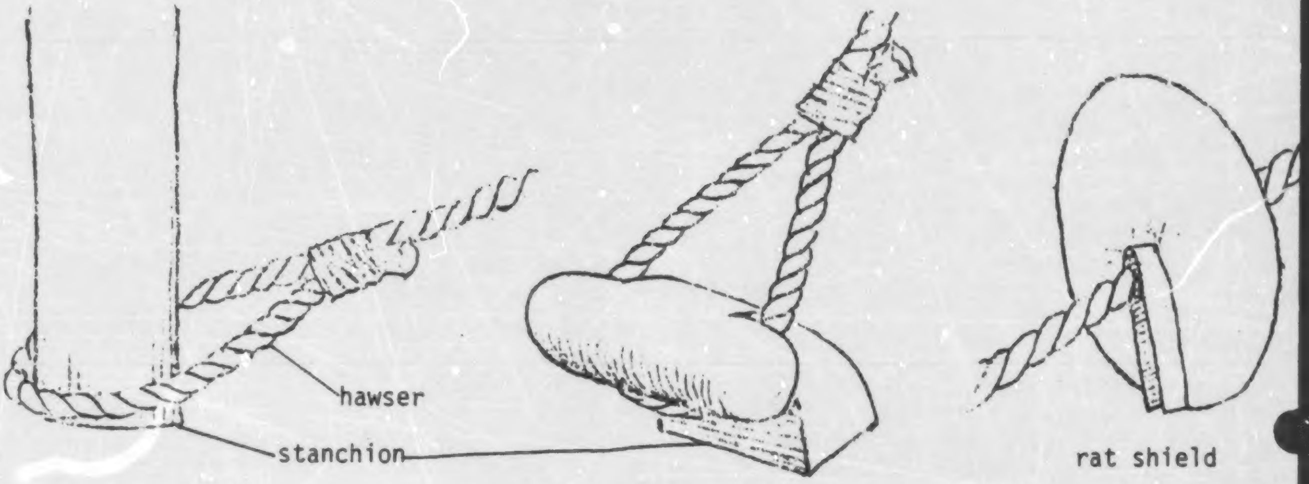
KEY

1. a. The picture above shows a cargo ship. The boxes which the ship is carrying are called containers. (The correct answers are underlined). Your students will have to deduce this information from the picture itself which shows the containers loaded as deck cargo.

   b. The boxes which the ship is carrying are called containers. This question is designed to give your students a chance to revise their answer to part a.

2. The specific answer is that the ship is tied to the dock with large ropes. The question is intended to get your students thinking about the steps involved in the whole process. The particular step they choose is as critical as the thought process.

3.



4. Overloaded ships run a much greater risk of swamping and sinking in poor weather than properly loaded ships. Swamping and sinking are obviously dangerous to sailors.

5. Since the Bahama Star is in freshwater, the boat will sink to the "F" mark when fully loaded with peanuts. This question assumes that your students know that New Orleans is not in the tropics.

6. Your students can find five port related jobs by going back to the text. Hopefully, the text will also suggest other jobs. Five jobs might include: longeshoreman (longshoreperson?), harbor pilot, ship captain, ship crewperson, crane operator, fork lift driver, etc.

7. Lots of things sold near you were probably carried on a ship. Ships are particularly well designed for transporting large, relatively low value cargos over long distances. For example, ship cargos range from imported cars, electronic equipment, bananas, and coffee to coconuts.

KEY - word search

TRANSPORTATION

```
. . . . . . . I N T E R T I D A L O
. . . . . . . . . R . . . . . . G .
. . . . . . . . E . . . . L . R . .
. . . . . . . K . . . . L . A . . .
P O R T . . N . . . . O . C . N . .
. . . . . A . . . . S . . . R . . .
. . . . T . . . . M . . . E . . . .
. . . . . . . . I . . . T . . . . .
. . . . C . W L . N . S . . . . . .
. . . . . O P . O . . . . . . . . .
. . . . B . N I . R . . . . . . . .
. . . . . E H T E . . . . . . . . .
. . . . N C . S A . . . . . . . . .
. . . A N T W . . I . . . . . . . .
. . R A O A . . . . N . . . . . . .
. C T L H . . . . . . E . . . . . .
. S I . . . . . . . . . R . . . . .
. P . . . . . . . . . . . S . . . .
```

Key Words

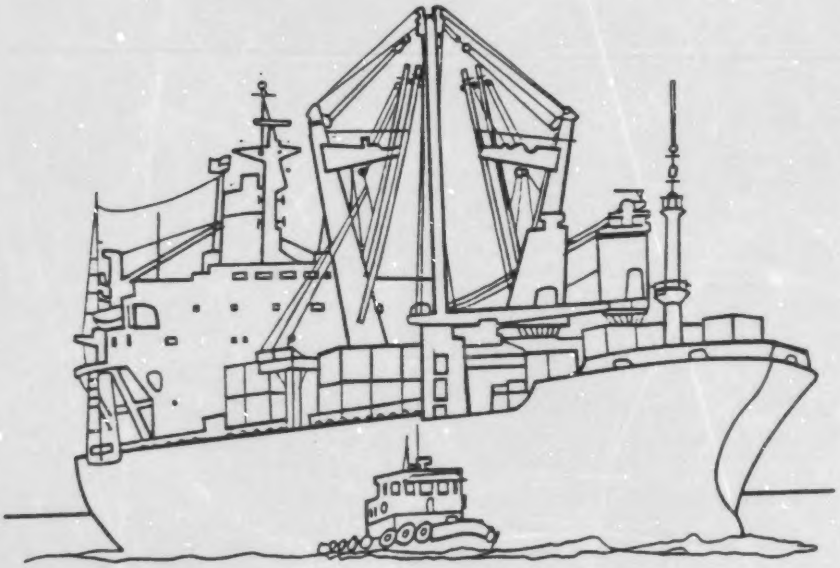
bow
cargo
compartments
container
crane
fork lift
funnel
harbor
hawser

holds
intertidal
load line
longshoremen
moving van
passenger
pilot
Plimsoll
powder

port
stanchion
stern
solid
tanker
vertical
vessel
wharf

TRANSPORTATION

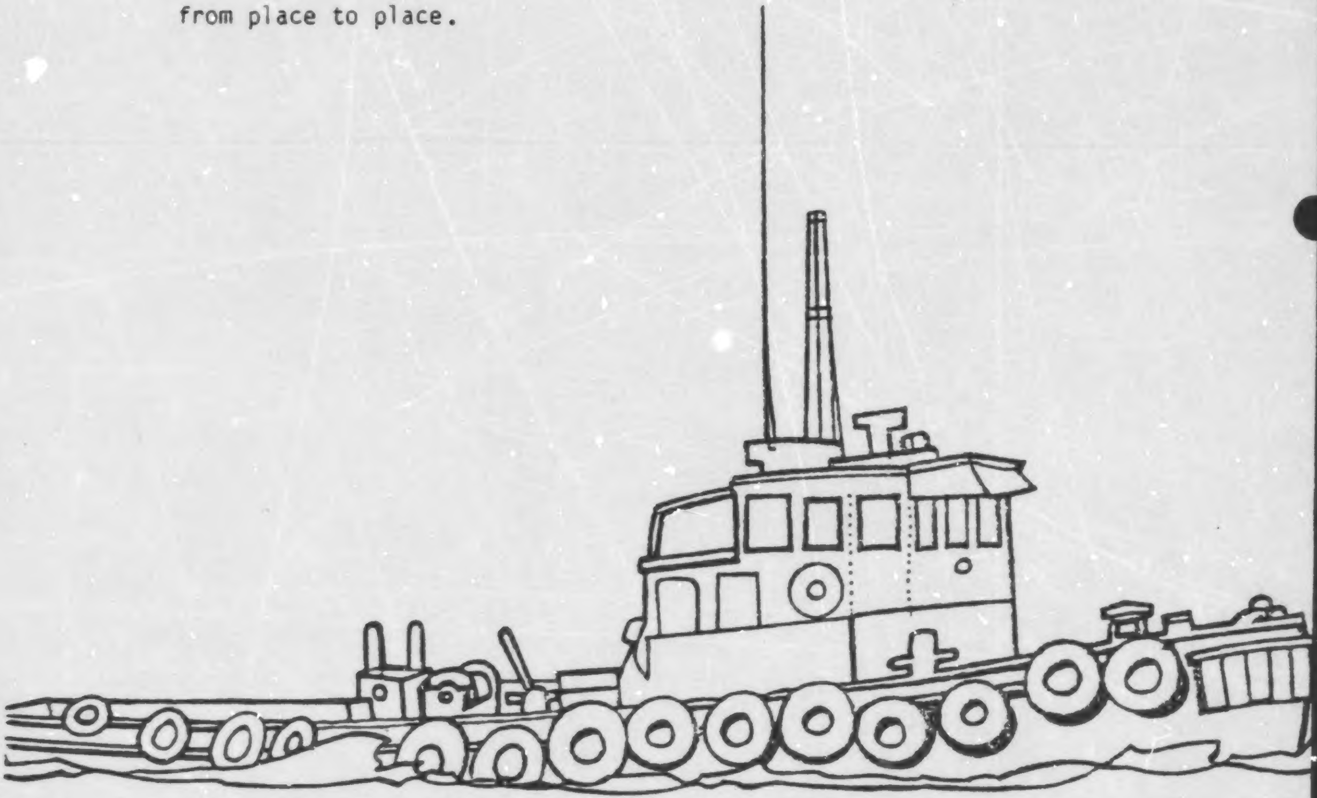
Intertidal ports are busy places. Ships come from all over the world to load and unload their cargo. Products we use every day come to us by ship. Cargo ships carry solid things like lumber, fruit, machinery, and shoes. Many new cargo ships carry containers. The containers are the size and shape of moving vans. Containers can hold just about any solid objects. Tanker ships carry liquids or powders in their holds. A ship's holds are the cargo compartments below deck. Ships also carry people across the ocean. These special ships are called passenger liners or cruise ships.



1. The picture above shows a ____________ ship and a smaller tug boat. The boxes which the ship is carrying are called _________________

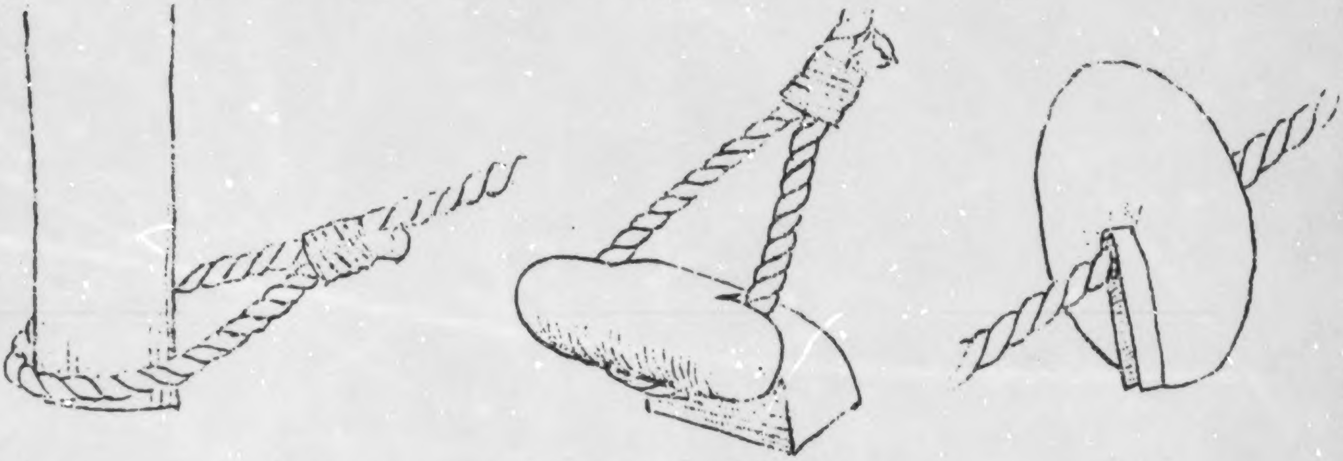
Ships approaching port are met at sea by a harbor pilot. The harbor pilot guides the ship into the port. Being a harbor pilot is an exciting job. Pilots have to board big ships from very small boats. Sometimes the water is very rough. The pilot also directs the docking.

Tug boats wait near the wharf or terminal. They will help push the ship into place. The tug boat captains take their orders from the harbor pilot. Tug boats and their crews work hard. It takes a lot of skill to guide big ships to their docks. Tug boats also push barges from place to place.



2. The tug pushes the ship into place near the wharf or terminal. What is the next step in getting the cargo to you?

When the ship gets into the proper spot, more action begins. Men called longshoremen moor, or tie, the boat to the wharf with large ropes. These ropes are called "hawsers". The hawsers are fastened to several posts called "stanchions" The hawsers will have some flat metal disks attached to them. These disks are rat shields. They keep rats from climbing on or off the ship.



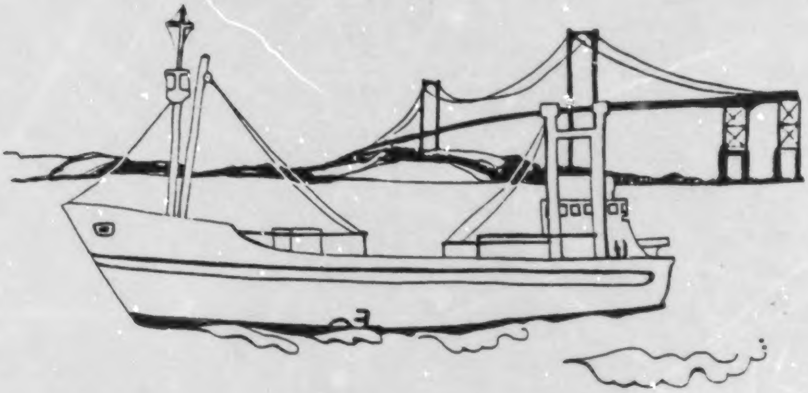
3. On the pictures above, label the following:
    a. hawser
    b. stanchion
    c. rat shield.

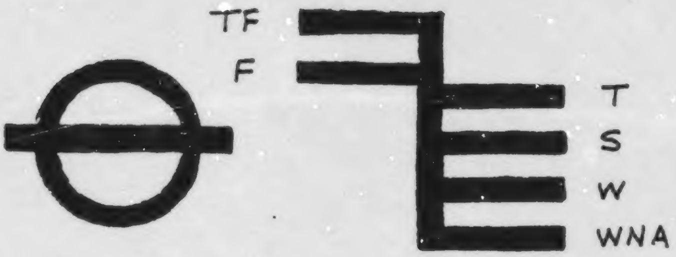
You can learn a lot about a ship by just looking. You can tell what country the ship is from. All ships in port wear their country's flag on the stern. The stern is the "back" of the ship. The flag of the country the ship is visiting flies from the mast. The ship's name is painted on the bow, or "front", of the ship. The home port is painted on the stern. You can also tell what company owns the ship. Ships from the same company have their funnels, or smokestacks, painted the same way.

A mark is painted on the side of every large ship. It is called "Lord Plimsoll's" mark. Samuel Plimsoll was born in Bristol, England in 1824. Plimsoll bought and sold coal. The coal was shipped in sailing vessels. Plimsoll saw many ships sailing with heavy loads. The shipowners were heavily insuring their vessels against loss. Then the ship owners were overloading the vessels. Many vessels sank in storms. The shipowner might not lose any money. The danger to the sailors on the ships, however, was very great.

4. Why was it dangerous to the sailors to sail on overloaded ships?

Plimsoll decided to do something. He wanted to make the people aware. First, he wrote a book called Our Seamen. His book succeeded in making the government act. The "Merchant Shipping Act" was adopted in 1876. The law fixed the limits to which a vessel may be loaded. The load line shows how low in the water the ship may ride. The line still appears on the side of all large ships. It is called the Plimsoll line or "Lord Plimsoll's mark".





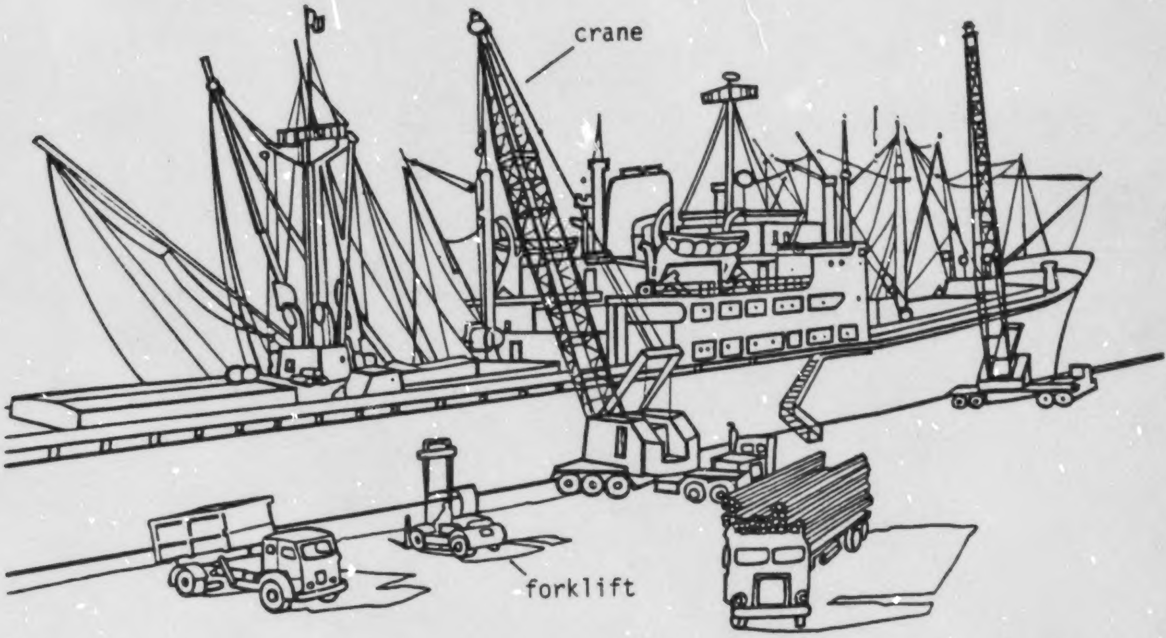
PLIMSOLL MARK

Today, shipbuilders determine the load line. Workers engrave the mark on the side of the ship. The Plimsoll mark helps ensure the safety of the vessel and crew. Let's look at the Plimsoll mark shown above. The Plimsoll mark measures a vessel's safe loading. The markis good in any water and in any season. There are two marks to the left of the vertical line. These are the depths to which the vessel may be loaded in fresh water. The "TF" shows the depth in tropical fresh water. The "F" shows the depth in other fresh water. The right side of the line is the salt water side. The vessel may be loaded to "T" in the tropics. The remaining letters are for other waters. The vessel may be loaded to "S" in the summertime. It may be loaded to "W" in the wintertime. The "WNA" is a special mark. It is for ships sailing in the North Atlantic Ocean in the wintertime. These ships can only be loaded to "WNA".

Why so many marks? Perhaps you have guessed by now. Ships float differently in different kinds of water. Let's look at a vessel loaded in fresh water to the mark "F". When it enters the ocean, it will float at the line "S". Why does this information matter to anyone? Well, we've seen that at one time ships were overloaded. This information protects the crews. It is also important to the shipowner. The same ship can safely carry more cargo in the summer than in the winter.

5. The Bahama Star is taking on a cargo of peanuts at New Orleans. New Orleans is on the freshwater Mississippi River. The boat sinks as the peanuts are loaded. Which Plimsoll mark letter will be at the water's surface when she is fully loaded?

The ship's cargo is handled at the port in different ways. It is moved to the dock by a small crane. It is loaded on a truck by a fork lift. A giant container crane lifts containers off and on the ship. The crane operator sits high above the ground on the crane.



Liquid cargos are pumped off tankers. These caryoes are stored in giant storage tanks. Powders are unloaded by conveyer belts. The belts transport the cargo to waiting trucks or warehouses.

6. As you can see, a port provides many jobs. List five jobs performed by workers that are related to the port.

a.
b.
c.
d.
e.

Not everyone lives near a port. Cargo must be moved from the port to inland cities and towns. Cargo is transferred from the ship to trucks, trains, or airplanes. Cargo from a single ship may find its way to many towns like yours.

7. What are two things sold where you live that were carried on a ship?

a.
b.

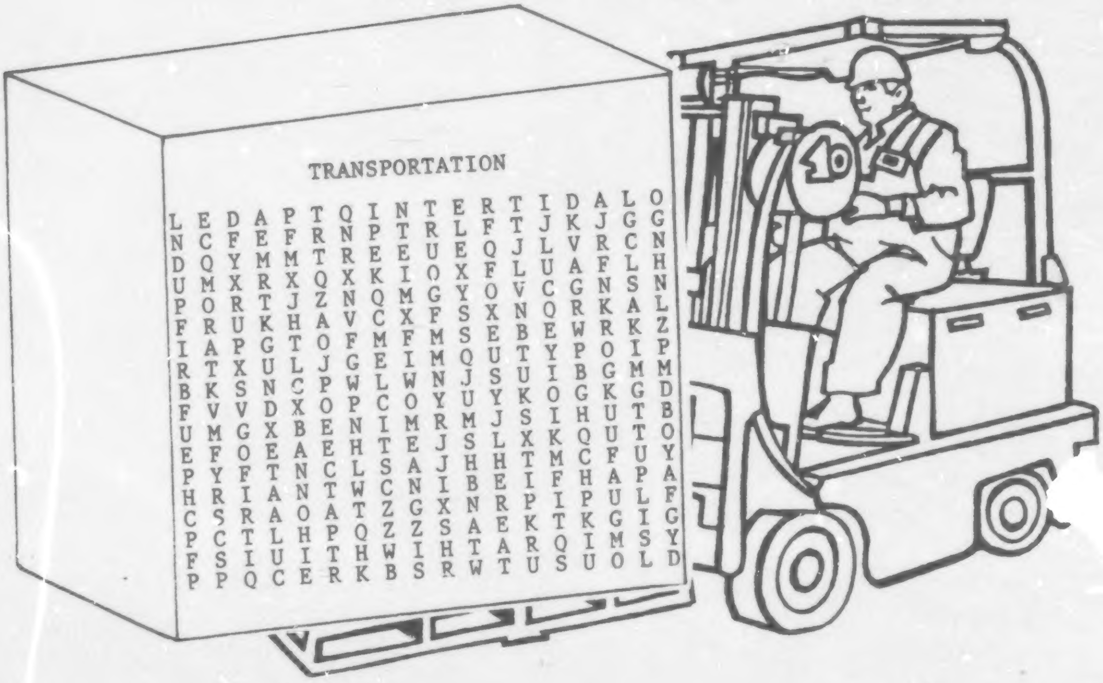
Intertidal Ports

Intertidal ports are busy places. The word search below will help you remember some of the port activities.

THERE ARE 12 WORDS HERE - CAN YOU FIND THEM?

HERE ARE THE WORDS TO LOOK FOR:

BOW
CONTAINERS
HAWSER
PILOT
PORT
STERN
CARGO
CRANE
INTERTIDAL
PLIMSOLL
STANCHION
TANKER



TRANSPORTATION

```
L E D A P T Q I N T E R T I D A L O
N C F E F R N P T R L F T J K J G G
D Q Y M M T R E E U E Q J L V R C N
U M X R X Q X K I O X F L U A F L H
P O R T J Z N Q M G Y O V C G N S N
F R U K H A V C X F S X N O R K A L
I A P G T O F M F M S E B E W R K Z
R T X U L J G E I M Q U T Y P O I P
B K S N C P W L W N J S U I B G M M
F V V D X O P C O Y U Y K O G K G D
U M G X B E N I M R M J S I H U T B
E F O E A E H T E J S L X K Q U T O
P Y F T N C L S A J H H T M C F U Y
H R I A N T W C N I B E I F H A P A
C S R A O A T Z G X N R P I P U L F
P C T L H P Q Z Z S A E K T K G I G
F S I U I T H W I H T A R Q I M S Y
P P Q C E R K B S R W T U S U O L D
```

TEACHER BACKGROUND - Plimsoll Floats!

Why do boats float? Does a boat in salt water float differently than one in fresh water? "Plimsoll Floats!" is designed to provide your students with a chance to answer these questions. The six activities which follow spring from ideas originally appearing in the Elementary Science Study booklet Clay Boats (Educational Services Incorporated, Watertown, MA., 1966, Developmental Teaching Edition).

Any object placed on the water's surface will sink just far enough to move aside - or displace - a weight of water equal to that of the object. If the object is dense, like a block of clay, it will sink. A boat's clay hull will float, however, since the clay is not concentrated in a lump, but encloses a volume of air that, even combined with the weight of the clay, weighs less than an equal volume of water. The activity cards allow your students to derive the essential components of this law of displacement.

Salt water is more dense than fresh water. Because of the salt dissolved in the water, a given volume of salt water weighs more than the same volume of fresh water. As a result of the greater density of the salt water displaced, an object will float higher in salt water than in fresh. In fact, some objects (like a fresh egg, try it) will float in salt water but sink in fresh. Caution your students to look carefully for differences in the water line and carrying capacity of their boats as they repeat activities 3 and 4 using salt water.

The clay boat activities are fun. They also provide your students with opportunities to think, plan, experiment and wonder. These activities provide an opportunity for inquiry and inductive learning.

The activity pages are designed to be made into task cards. After duplication cut the pages in half. You may wish to duplicate them on card stock. Clayola comes in one pound packages. Each package contains four sticks of clay. Marbles and crayons are used for boat cargo because of their uniform sizes and resistance to water damage. This activity will cause water spills. Provide ample sponges and paper towelling to clean up the excess water.

Duplicate the activity pages. One set is recommended per student. This activity is best accomplished by individual students who are grouped into teams of four for sharing ideas and results. Be aware that some of your students will face such open-ended activities with trepidation. Students are used to having detailed procedures which they must follow. This activity challenges them to be creative, a skill it seems we seldom require. Plan to allow for an open-ended discussion in which you help your students derive the principals of displacement and flotation from their observations.

KEY

The answers to many of the questions on the six activity cards will vary because of their dependence upon the observations made by your students.

Some of the expected results follow. Be sure to discuss variations from the expected. These discussions should focus on the quality of the observation, reasons why observed differences could have occurred, etc.

Activity 4

The water line will move up the side of the boat as the marble people are added. The pencil mark (representing the old water line) will go underwater.

Activity 5

One would expect the boat to carry more marble people in salt water than in fresh. It is possible, however, that because of the relatively large size of the marbles, your students will find the boat carries the same number of marbles.

Activity 6

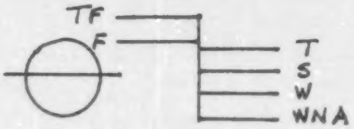
The new water line will be lower than the first one made in #4 because the boat floats higher out of the water.

It is expected that your students will find that boats in fresh water float lower than boats in salt water and can carry less weight before they sink. Discuss any variations from these expectations in terms of the observations made by your students.

Lord Plimsoll's mark has a line for fresh water and one for salt water because the ship can carry more weight in salt water than in fresh and it would be possible to overload a boat simply by moving a loaded boat from salt to fresh water.

KEY WORDS

bow
balance
charts
clay
compass rose
course
float
knowledge
port
sink
starboard
stern
weighs



PLIMSOLL FLOATS!

On the side of every large ship is painted "Lord Plimsoll's" mark. The mark is named after Samuel Plimsoll, "The Sailor's Friend". Plimsoll was born in 1824 in Bristol, England. Plimsoll watched shipowners overload ships. He also watched overloaded ships sink in bad weather. He wanted to stop the practice of overloading. Plimsoll called the practice to the attention of the government. Eventually, the "Merchant Shipping Act" was passed. The act provided for a series of load lines. The load lines show how much cargo a ship can carry. This series of lines is called the Plimsoll mark.

The Plimsoll line is very useful. Still, it doesn't tell us much about how a boat works. Why do boats float? Is there a difference between boats in freshwater and saltwater? In the following activities you will have a chance to answer these questions.

Materials:

activity
cards
clear plastic container, dishpan, plastic shoe box or
similar container
water
clay, plasticine (about 1/4 to 1/2 pound)
marbles (people)
plastic cups
aluminum foil
balance
crayons (cargo)
sponges, paper towels for clean-up
salt (one cup)

Procedure:

1. Obtain a set of activity cards. Begin with card #1 and follow the directions found on the card. In the same way, complete all six cards.

Plimsoll Floats! 1

Obtain a block of clay.

What do you think will happen if you drop the clay in water?

TRY IT!

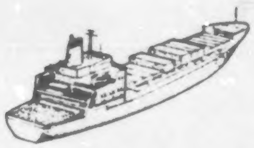
What did happen to the clay when you dropped it in the water?

Can you shape a piece of clay so that it will float?

TRY IT!

Write down the different ways in which you tried to make the clay float. Circle the ways that worked.

Plimsoll Floats! 3



Obtain 5 or 10 marble people

Float your best boat from #2. See how many marble people you can add before the boat sinks. Write down the number of marble people your boat can carry without sinking. ______________

How can you change your boat so that it will carry more marble people?

TRY IT!

In the space below, write how you made your boat better.

Plimsoll Floats! 2

Divide your block of clay into three equal pieces.

Make three clay boats with different shapes.

Try floating your three boats.

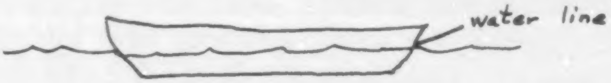
In the space below: For each boat, draw a picture that shows its shape.

Write a sentence about each boat.

Circle the drawing of the boat which floats best.

Plimsoll Floats! 4

Refloat your best boat from #2. Use a pencil to make a mark at the water line. The water line is the place where the water meets the side of the boat.

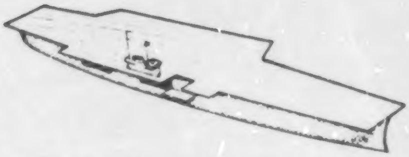


What will happen to the water line if you add marble people?

TRY IT!

In the space below write what happened.

Plimsoll Floats! 5

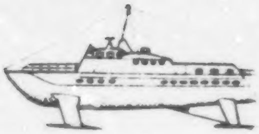


Obtain a cup of salt. Pour the salt into the water in your container. Stir the water until the salt dissolves.

Float your best boat from #2. Again, see how many marble people you can add before the boat sinks. Write down the number of marble people your boat can carry without sinking. __________.

Did your boat carry more/less/the same number of (circle the correct answer) marble people in salt water than in fresh water?

Plimsoll Floats! 6



Refloat your boat from #2. Again, use a pencil to make a mark at the water line.

Is your new water line higher or lower than the one you made in #4?

From my observations, boats in fresh water float higher/lower (circle the correct answer) than boats in salt water.

From my observations, boats in fresh water can carry more/less (circle the correct answer) weight before they sink.

Lord Plimsoll's mark is useful to tell when a ship is overloaded. Why does the mark have lines for both fresh water and salt water?

TEACHER BACKGROUND - The Great Boat Float

"The Great Boat Float" is designed as a family activity for your students to do at home. The activity was developed by the Virginia Institute of Marine Science, School of Marine Science, College of William and Mary under a National Science Foundation grant. The activity is included here so that you may involve your students' families in the science activities occurring in your classroom.

Duplicate the activity pages. One set is required per student. The activity is designed to be done in a family setting. Give your students a little background information related to the activity and stress the fun they can have making the discoveries as a family. Since the activity will have to compete with television, your buildup is critical. Obviously, there will be a range of home situations within any particular class. Stress that your students can do the activity with friends, relatives or with whomever they spend their time.

By way of preparation, read the activity and alert your students to the format for recording their observations. This activity is a natural sequel to "Plimsoll Floats!". Plan to spend a little time talking about the activity as a follow-up back in the classroom. This will not only cement the concepts but will provide positive reinforcement for your students.

THE GREAT BOAT FLOAT

Can you answer these questions?

Why are metal ships able to float? How are they able to carry heavy cargo? Do they float higher in fresh water or salt water?

In this activity you and your family will work together. You will be conducting experiments with boats and exploring how they float. Challenge your family to a boat building contest! Whose boat will carry the most cargo? Let's get started, and good luck!!

Preparation

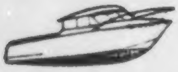
1. You will need:
    - aluminum foil
    - small nails, pebbles, paper clips or several wire objects which can be used as weights or cargo for the boats
    - sharp pencil
    - ruler
    - scissors

2. Fill your sink with at least 4-6 inches of water.

Action

1. Gather your family together. Explain that you are going to hold a boat-building contest. Each person will build a boat. The boat which carries the most "cargo" will be the winner.

2. Give each member of your family a piece of aluminum foil. The foil should be a 6 inch by 6 inch square. Consider what design the boat must have in order to float. Then build your boats!



3. Place each boat in the water. Test it to see if it floats. If it does not, try building another boat. Continue until you make one which floats.

4. Float the boats. One at a time, place small objects in the boats. You might use paper clips, nails, pebbles, etc. For this "cargo", you will want to compare how much cargo each boat can hold. Why is it important that everyone use the same type of weight?

5. Observe how many objects each boat can hold and still float. Record your findings on Table 1.

6. Not happy with your boat? Try another design. Make and test your new boat. Record these results in Table 1.

7. Take the boats out of the water and empty. Then turn the boats over. Obtain a needle or pin. Carefully punch several small holes in your boat bottom. Punch from the outside of the boat to the inside. Return the boats to the water one at a time. Did each one float? Does the water come in through the holes? Record your findings in Table 1.

8. Are your boats still afloat? Replace the objects in your hole-filled boats one at a time. Observe how many items the boats can hold and still float. Record your findings in Table 1.

9. Take your boats out of the water and empty. Again, turn the boats over. This time, punch several larger holes in your boat. Use the sharpened point of a pencil. Punch from the outside of the boat to the inside.

10. Repeat step 8 and record the results in the table.

More Things to Do

Preparation

1. Try using a different material to build boats. As a family, build two boats that are exactly alike. Be sure to make them out of the same material. Try a design and size different from the first boats. These are good materials to use.

styrofoam
heavy cardboard
plastic
clay
wax paper

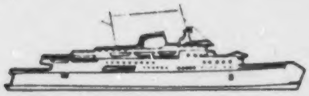
2. Find two containers (tubs, pans or buckets). Fill one with water. Fill the other with one of the liquids from this list.

cooking oil
vinegar
soda pop
syrup
salt water (mix about 1/4 cup of salt for each quart of water
or 1 cup of salt for each gallon of water)

Action

1. Find Table 2 of the Observation Sheet. Record the names of the persons who built the boats. Record the materials used to make the boats. Record the liquids you used in each container.

2. Place the first boat in the water. Place the second in the other liquid. Did they float? If they do not, try building another type of boat. Continue until you make a pair of like boats which float.



3. Begin placing "cargo" in the boats one at a time. How many items was each boat able to hold and still float? In which liquid were they able to carry more cargo? Record your findings (observations) in Table 2.

AFTERWARDS

Water and other liquids push up on the objects put in them. This upward force is called buoyancy. At the same time the earth's gravitational force tries to pull the objects down. This downward force is called gravity.

If something sinks in water, gravity is greater than buoyancy. The force pulling down is greater than the force pushing up. When something floats, buoyancy is greater than gravity. The force pushing up is greater than the force pulling down. If an object has the ability to float, it is buoyant.

The more dense ("thicker") the liquid, the greater its upward force. For example, salt water is more dense than fresh water. Salt water has a greater upward force (buoyancy) than fresh water. Objects are more buoyant (float better) in salt water.

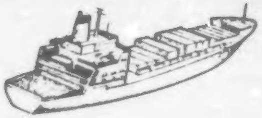
The buoyant effect of water is important. It makes all types of ocean, river and lake transportation possible. Ships float because the force of gravity pulling the ship down is less than the force of the water pushing the ship up. This may seem hard to believe. Ships are made of steel and weigh many thousands of tons. Remember though, ships have air spaces.

Empty ships ride high in the water. When loaded with heavy cargo, they ride low in the water. Overloaded boats sink too deeply in the water. This can be dangerous. Water may come over the sides of the boat. When this happens, the weight of the boat increases. Water, which is heavier than air, replaces the air in the boat. If too much water enters in the boat, it sinks. Did this happen to your boat?

The Plimsoll mark is found on all large ships. This mark shows proper loading in fresh or salt water. Salt water has a greater upward force (buoyancy) than fresh water. Objects are more buoyant (float better) in salt water. Shippers must remember this. What might happen to a ship loaded in the ocean and sent to the Great Lakes? It would sink, wouldn't it? This is the last thing shippers want.

Table 1.

OBSERVATION SHEET FOR THE GREAT BOAT FLOAT



In the table, record the names of the persons who built boats. Record your observations as you do the experiment.

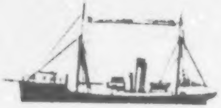
NAME OF THE PERSON WHO BUILT THE BOAT			
KIND OF CARGO (LIST OBJECTS)			
NUMBER OF OBJECTS WHICH EACH BOAT HELD			
DID EACH BOAT FLOAT WITH THE SMALL HOLES?			
DID EACH BOAT WITH SMALL HOLES FLOAT WITH CARGO?			
HOW MUCH CARGO COULD EACH BOAT WITH HOLES CARRY?			
DID EACH BOAT WITH LARGE PENCIL HOLES FLOAT?			
DID EACH BOAT WITH LARGE HOLES FLOAT WITH CARGO?			
HOW MUCH CARGO COULD EACH BOAT WITH HOLES CARRY?			

1. Draw a picture of your boat on this page.
2. Measure the boat you made.

How long was it? ________

How wide? ________

How high? ________



Name ____________________

Teacher's Name ____________________

Date ____________________

Table 2. OBSERVATION SHEET FOR "MORE THINGS TO DO" SECTION OF THE GREAT BOAT FLOAT

	First Container	Second Container
NAMES OF PERSONS WHO BUILT THE BOATS		
MATERIALS BOATS WERE MADE FROM		
NAME THE LIQUIDS YOU CHOSE FOR YOUR EXPERIMENT		
WHAT TYPE OF CARGO DID YOU CHOOSE? LIST THE OBJECTS.		
HOW MANY ITEMS WAS EACH BOAT ABLE TO CARRY?		

THOUGHT & DISCUSSION

1. In which liquid did the boats float better (was able to carry more cargo)? ____________________
2. Why? ____________________
3. Did these boats float better in water than the aluminum boats? __________
4. Do you think this was due to the design of the boat or the material you used to build it?

   ____

5. What experiments could you do to answer question 4?

   ____

   ____

TEACHER BACKGROUND - Marsh Beach: A Simulation of Coastal Planning

Simulations are operating models of real life situations. They may be about physical or social situations. The Marsh Beach simulation is adapted from "Land Use for Marsh Beach", a 4-H publication by the Alabama Cooperative Extension Service.

Many simulations involve gaming. A game is defined as something enjoyable--however serious it might be--involving competition for specified objectives and observing rules.

Some simulation games are based on environmental issues. What are some benefits of using simulation games as an instructional technique for investigating environmental problems?

* They're fun.
* They get people involved.
* They help to prepare people for becoming involved with solving environmental problems.
* People analyze cause-and-effect relationships of environmental issues.
* People are put in role-playing situations where they have to suggest alternative solutions to environmental concerns.
* People are forced to evaluate the consequence of decisions in discussion or on paper before these decisions are carried out in reality.
* People interact with each other in the decision-making process.

So....simulation games not only develop understandings about problems in the environment and develop awareness and concern about those problems, but they help people develop skills they need for citizen action and involvement in environmental management.

During this investigation your students will participate in a simulation game concerning land use in a hypothetical community. They will analyze what they have done; present their ideas; and think critically about real environmental issues in their community. The techniques used combine those of simulating real issues, and the element of role-playing. Students assume the roles of decision-makers in a simulated environment and compete for certain objectives according to specified procedures and rules. Before you begin the simulation with your class, be sure to read the entire Teacher Background and student text sections. This preparation will minimize confusion as you proceed.

Part I - Background

Introduce the simulation game and background information on Marsh Beach. Give your students 10 minutes to read the background information for Seaport City and to list some possible uses of the vacant Marsh Beach area.

(Note: When most people have started to write down uses on Part I, Members Guide, go ahead with question A.)

A. "What are some possible uses for the undeveloped land?" As people respond, write all comments on board, just as they say them. Don't paraphrase for them unless they are too wordy, in which case, ask: "How shall I write that on the chart?" If they give major categories right away, like Recreation or Industry, say, "Can you give me an example of that?" Number the items as you go along--to simplify identification later. When you get 15 or 20 items, STOP.

B. "Which of these uses are similar?" Designate similar uses by letters--a, for all of one type; b, the next, etc. When most are designated with a letter, or the groups seem to run out of thoughts, STOP. It's okay to change the groupings if the students change their minds along the way in B above.

C. "What label could we give to all the items in a? What label could we give to Group b? Examples: Recreation, Industrial, Utilities, Housing, Commercial." It's okay if they suggest more than one label for a Group; write them both down.

Part II - The Choices

Developing Presentations

1. Divide the class or group into the number of categories decided on in C. There shouldn't be more than 6-10 in each group. Assign each group to one of the use categories.

2. Each group is to represent the special user group assigned. For example--Oilman, Realtor, Environmentalist, Industrialist, Harbormaster, Sportsman, etc.

3. Begin Part II and inform the students they have 10 minutes to list and analyze possible uses for the vacant land in the assigned category. They may consider those listed on the board in their category plus any other possible uses they can think of for the category.

Part III - The Strategy

Begin Part III and inform the students they have 20 minutes to plan their strategy to present to the City Planning Board. As the students approach Part III, make sure they acknowledge and construct plausible support for their strategy.

1. Ten minutes into Part III, have each group select one of its members to meet together as the City Planning Board. Take the Board aside and tell them they will be responsible for hearing the presentations and deciding upon the best one. Their job in the next 10 minutes is to:

a. Develop the criteria they will use in evaluating the proposals.

b. Elect a chairman to preside during group presentations.

c. Develop some kind of matrix (see sample below) they can each use while the presentations are being given to record their evaluations.

			Groups	
		Home Owners	Boiler Makers	Ship Owners
Criteria	New Government Services			
	Economic Benefits			
	Tax Changes			

2. Twelve minutes after groups start planning Part III, remind them they have 8 minutes left to have their verbal and visual presentation ready. Let groups have 5 more minutes to finish if needed.

Part IV - The Board Meeting

1. Have the City Planning Board enter the room and sit up front. Appoint a timekeeper to cut all presentations off at 3 minutes (give 2-minute warning). Announce: "Because of time, there will be no rebuttals or discussion." But the Board may want to ask questions or have rebuttal time after all presentations. However, allow only 5-10 minutes for this part so it won't get out of hand.

2. After #1 is finished, the Board retires for 5-10 minutes to select the best proposal.

3. While the Board is meeting, each small group is to develop a list of criteria they think should be used in choosing between the plans submitted.

4. Seaport City Planning Board announces their decision and gives reasons why.

5. Seaport City Planning Board reads its criteria aloud.

Part V -Afterward

An adequate discussion of the questions in Part V is one of the most important aspects of the activity because it emphasizes that we need a variety of information and data before we can intelligently make a land management or environmental decision to best meet the needs of people and their environment. This question list has all the elements that need to be considered in studying a local environmental issue or concern. It also includes elements of all the curriculum subject areas (social studies, science, language, arts, etc.).

1. Did new leadership emerge during this session? What factors enabled this to happen? Call on staff observers if used.

2. Did your group work as a team? What did your group do to insure participation by all members of the group?

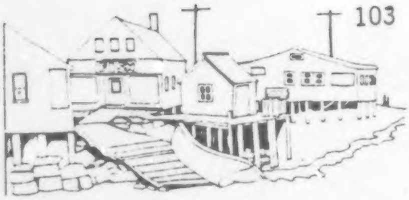
3. What happened in the groups? How did you feel as a person? What about the criteria used? How did each observer see the interaction in the groups?

4. What additional data would you like to have had for your groups? List on board, e.g.: topography, vegetation, economy of area, railroad, shopping center, adjacent land, climate, soil survey, historical information, flood plain, wildlife, interest of board of control, money available, educational needs, regulations by State, existing zoning, political climate, population information (age needs, race, jobs). What elements in the community discussion might support each interest?

KEY WORDS

acreage
alternatives
analyze
City Planning Board
coniferous
consequences
developers
dredging
dunes
marsh
municipal services
public hearing
reservoir
sewage treatment
simulation
solid waste disposal
topography
utilization
visual display

MARSH BEACH: A Simulation of Coastal Planning



Part I - Background

Seaport City purchased a 3-mile Marsh Beach. The beach cost the city $3 million. Land along the seashore is sandy beach and dunes. These beaches and dunes cover one-third of the area. Another third is low brush and pines. The third on the Bay side is marsh. You will decide what are the uses of this land.

1. Obtain a map of Marsh Beach, Seaport City and colored pencils or crayons.
   a. Color the beach and dune area yellow.
   b. Color the marsh area green.

The Marsh Beach area has been purchased by Seaport City. The City Planning Board will decide how the property can best benefit the City.

Seaport City has a population of 250,000. The City is rapidly increasing in size.

The City's boundaries are being extended. The suburban fringe is expanding along the coast and up the river.

Industry is moving in adjacent to the interstate highways.

The rapid growth causes demands for more housing and more jobs. More people require additional municipal services. More people also want more recreational areas.

The City's harbor is the best within a hundred miles. Present harbor facilities are adequate. There are good rail and highway links. The channel, however, must be maintained by dredging. The channel will not accommodate the new supertankers.

The area next to the beach is rocky soil. It is covered with hardwood forest. The forest has little timber value. There are a few dairy farms. Most agricultural products are shipped in from other parts of the country. The land to the north is hilly with evergreen forest.

Large ships cannot travel up the Clearwater River. The Old Mill Dam blocks the way. The dam is just north of Interstate 1. The city water supply comes from the Clearwater Reservoir. Below Interstate 2, the water is used by several industries.

2. a. Color the Clearwater River and Clearwater Reservoir blue.
   b. Where does Seaport City get its drinking water?

Scientists have been working off shore. They believe that oil, sand and gravel may be beneath the surface.

Many groups are concerned with maintaining a scenic coastal environment. Others worry about maintaining the coastal fisheries.

Present sewage and garbage facilities are working at capacity.

The City Planning Board is going to hold a public hearing. During the hearing all interested groups may speak. They will be given the opportunity to air their proposals. The groups have many plans for the Marsh Beach area.

3. Use the above information to identify possible uses of the area.

List possible uses of the Marsh Beach below:

Part II - The Choices

Your group has been assigned a land use category. Your group should now analyze and list possible consequences of different land uses. List uses within your assigned land use category only. You will have 10 minutes.

Use	Advantages to land/people	Disadvantages to land/people

Part III - The Strategy

With your group plan a strategy designed to get your proposal accepted. You will have twenty minutes for this planning. You will also need to develop a 3-minute presentation. The presentation will be made at the next City Planning Board meeting. The presentation should be a proposal for developing the Marsh Beach. More than one person must help make the presentation.

On a separate sheet of paper outline your group's presentation.

Part IV - The Board Meeting

Select a spokesperson. The spokesperson will direct your presentation. Keep your group's presentation to 3 minutes.

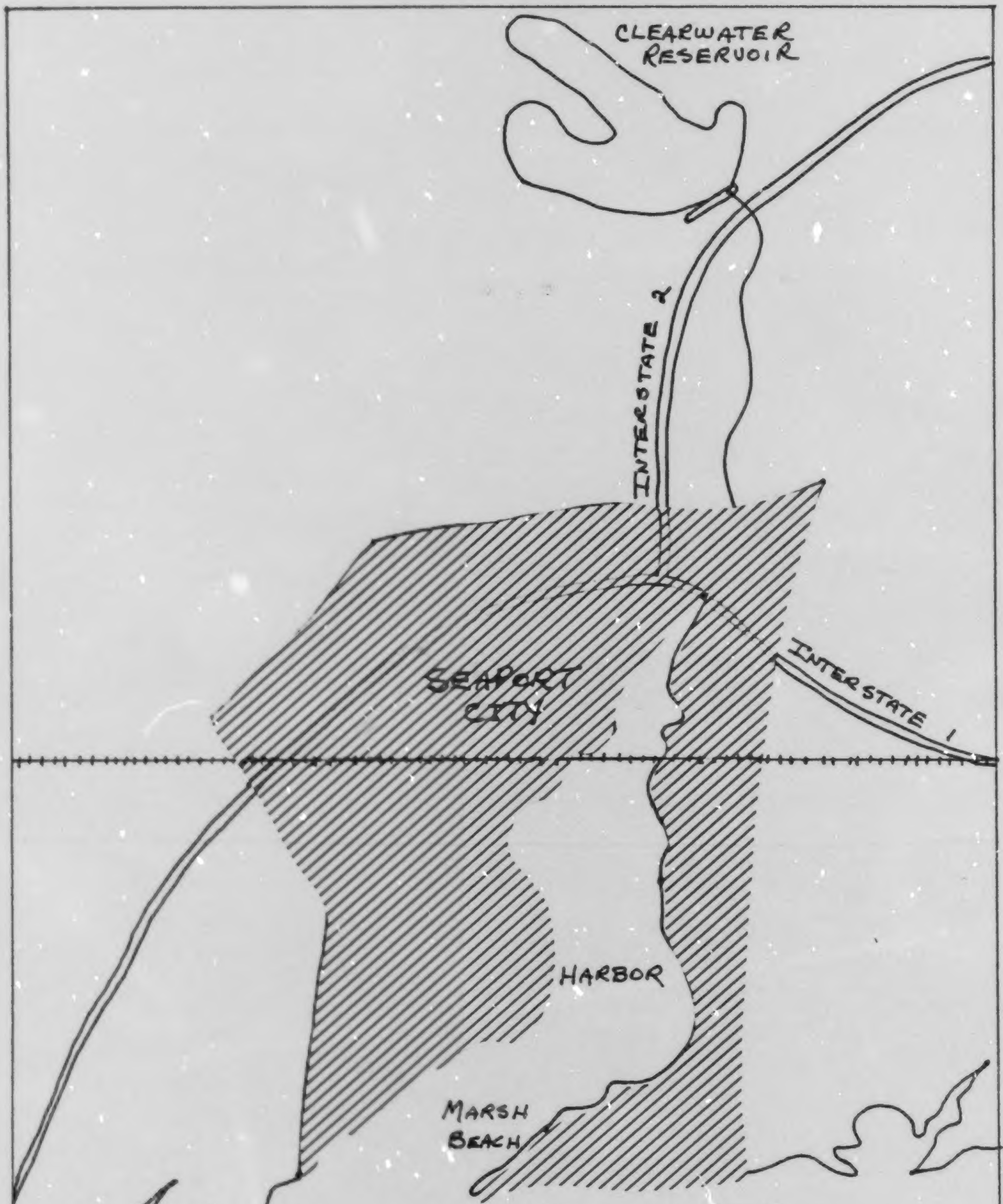
Part V - Afterward

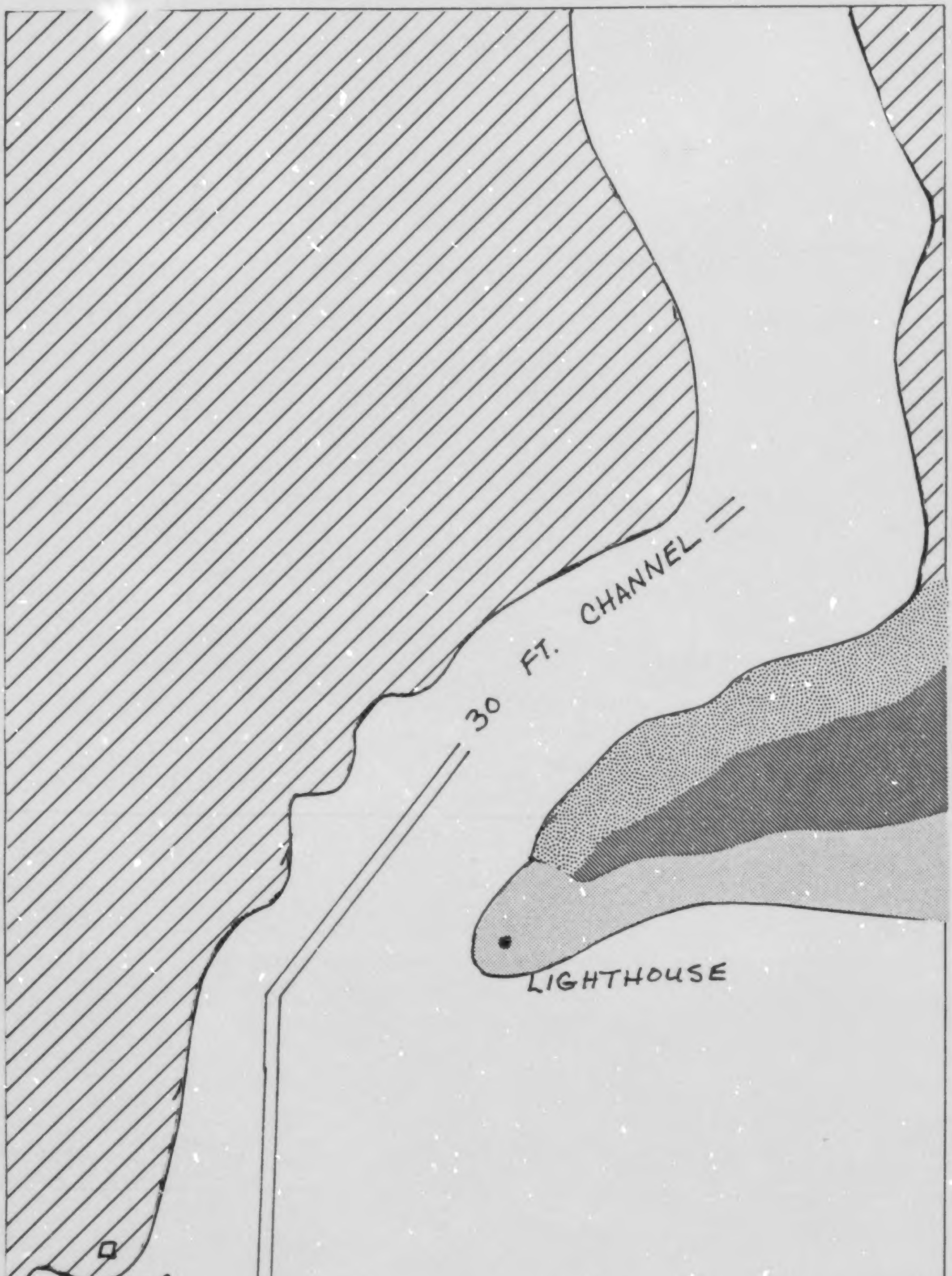
1. What additional data would have been helpful? List the areas on the board. What elements in the community discussion might support each interest?

2. What was the clearly defined problem in the Land Use Alternatives simulation?

3. What factors influenced the decision in the Land Use Alternatives simulation?

4. We assigned groups to fit each role in the Land Use Alternatives simulation. We all helped develop those roles. The roles came from the items we listed on the chart. What group of individual roles were identified? How were they identified?


CLEARWATER
RESERVOIR
INTERSTATE 2
SEAPORT
CITY
INTERSTATE 1
HARBOR
MARSH
BEACH
N


30 FT. CHANNEL
LIGHTHOUSE
POWER PLANT POINT
MARSH BEACH, SEAPORT CITY

SUGGESTED ADDITIONAL ACTIVITIES

1. Write a story about one of the occupations represented by the intertidal beaches.
2. Interview someone who works on a fishing boat.
3. Visit a store which carries sports fishing supplies.
4. Visit a boat building establishment.
5. Visit a diving equipment shop.
6. Discuss the various effects pollution would have on the intertidal beaches.

COMMERCIAL CRABBING

TEACHER BACKGROUND - Commercial Crabbing

This section requires some advance planning. Arrangements should be made to obtain live crabs (see activity: Observing the Living Crab). Crabs are a commercially important food item and interesting creatures. The material in this section can be used to stimulate discussions on topics ranging from regeneration of body parts to conservation. Encourage these conversations and direct them toward developing an appreciation of the factors facing organisms that live in the sea.

Each activity has a "Teacher Background" section which should be consulted prior to having your class do the activity. Duplicate the text pages and activity pages. One set is recommended per student.

KEY

1. Yes, re-growing body parts would be valuable for humans. We could replace limbs or organs lost to accident or disease.

2. Crabs eat old and dying marine life and clams, worms, small fish and other living marine life when they can catch them.

3. When a crab molts, it sheds its old shell and replaces it with a new one.

4. Carla Crab will lay 12 million eggs during her lifetime.

5. Chances of a crab egg reaching adulthood are very slim. From this example, only one in over a million crab eggs reach adulthood.

6. Being eaten, lack of oxygen, being removed from the water, or otherwise landing in an inhospitable environment might keep an egg from growing up.

7. The main commercially harvested crab in the Pacific Northwest is the Dungeness crab.

8. The Dungeness crab has a rounded shell.

9. Three ways to catch crabs are by hand, scoop and pot.

10. Crab boats fish as far as 600 miles off the coast.

11. "Shakers" remove the crab meat from the shells.

12. Some of your students will most likely have eaten crab.

KEY WORDS - Crabs

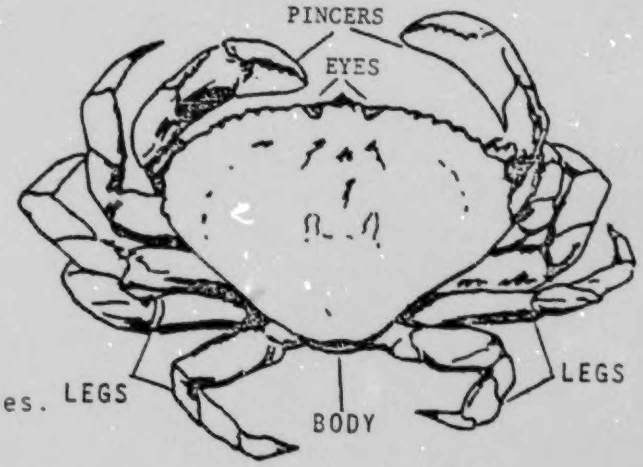
bait
bouy
caliper measure
commercial
crab
crab pot
depth distribution center
Dungeness crab
female
flexible
herring
inflate
inlet
king crab
larva
male
marine
migrate
molting
pincer
plankton
processing plant
regulations
rock crab
scavengers
scoop
shakers
skeleton
smelt
squid
tanner crab
tide
tide pools

COMMERCIAL CRABBING

The crab is one of the most interesting animals of the marine world. They can be found on most beaches. Crabs are one of the first animals one discovers while at the beach.

The crab's head, neck and chest is made of one piece. On this piece are two eyes on stems. This allows the crab to see in all directions around him. Crabs are interesting, because they can walk in any direction.

Crabs have eight legs and two pincers. The crabs use these two pincers to tear their food into smaller pieces. The pincers also protect them from their enemies. These pincers are very powerful. They can even break a person's finger. Crabs will sometimes fight among themselves. If a leg or pincer is broken off a new one will grow back.



A CRAB

1. Would re-growing parts be valuable for humans? ______________________

Crabs are scavengers. They eat old and dying marine life. But when they can catch them, they eat fresh clams, worms, small fish and other small marine life. The Dungeness crab feeds largely on small clams. It uses its pincers to chip away at the shells.

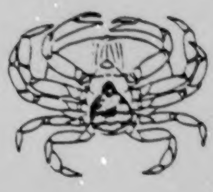
2. What do crabs eat? ____

As crabs grow their shell does not grow with them. Therefore, once or twice a year they must shed the old or too small shell. This is called molting. The crab will grow a new shell under his old one.

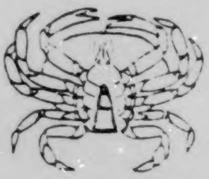
The crab then splits its seams. Then it backs away from his old shell. The new shell is soft and flexible. The crab pumps water into his new shell. The water inflates it to the proper size. The new shell takes time to harden. He protects himself by burying himself in the sand. Crabs often molt in early summer. We can say that a crab wears its skeleton on the outside. Unlike you, the crab changes skeletons as it grows.

3. When a crab molts, it ______________________________

You can tell if a crab is male or female, by turning it over and looking at its underside. The female crab has a wider space between her rows of legs.



A FEMALE CRAB



A MALE CRAB

Some mother crabs migrate to the mouth of a bay or inlet to lay their eggs. The mother crab carries her eggs on her stomach in a big mass. A medium sized female crab may have as many as 2 million eggs.

4. Carla Crab lives to be eight years old. She starts to lay eggs at the age of two. How many eggs will she lay in a lifetime? (Hint: she will lay 2 million eggs each year for six years.) ______________________________

____

Only two of these eggs would need to grow into adults to replace the mother and father crabs. We are not up to our knees in crabs.

5. How good are the chances of a crab egg becoming an adult?

____

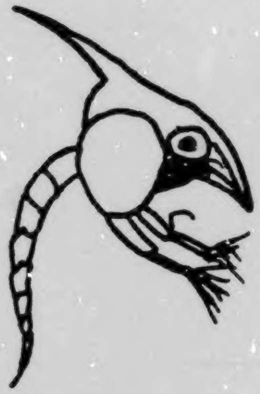
____

6. What are two things that might keep an egg from growing up? ____

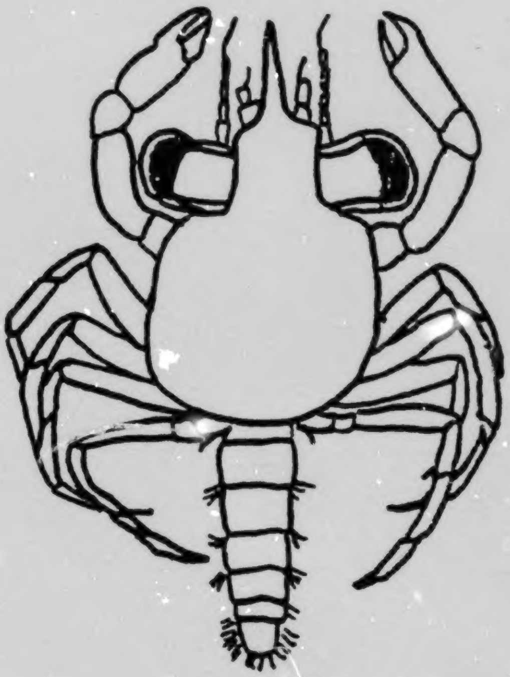
____

The eggs hatch, into crab larva. They drift freely in the water. Freely drifting plants and animals are called plankton. Many of these are eaten by fish and other marine life.

In fact, only one in about five million grow up. Some adult crabs live to be twenty years old.



Early free swimming stage
(Stays in this stage 31 - 49 days)



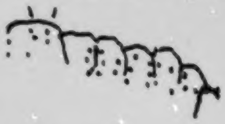
Later free swimming stage
(Stays in this stage 6 - 20 days)

Types Of Crabs

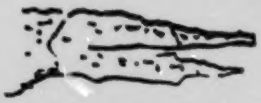
There are many different kinds of crabs. They come in many sizes. One kind found in Japan can have a shell 18 inches long and legs measuring 15 feet. Other crabs are very small. One kind is less than an inch in length. It often lives inside another animal such as a clam. Most of you have noticed crabs on our beaches. These are called "sand" crabs.

The Dungeness crab is the main crab harvested commercially in the Pacific Northwest. The Dungeness crab has a hard shell. It can be up to ten inches across. They are often found on sandy and grassy bottoms below the tidal range. They are found in the Puget Sound and ocean bays. However, many more are found in the oceans. The Dungeness crabs are easily recognized by their large, thick, meaty legs and pincers.

DUNGENESS CRAB



SHELL

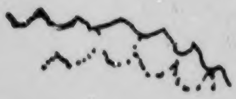


PINCERS

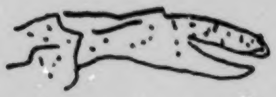
7. The main commercially harvested crab in the Pacific Northwest is the ______________________________

The rock crab is also found in the Pacific Northwest. It is not often harvested commercially. They are smaller and have less meat than the Dungeness crab. However, rock crabs are a good sports crab. They may be found in the inland waters along most kinds of bottoms.

ROCK CRAB



SHELL



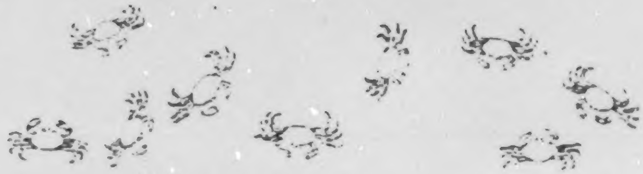
PINCERS

You can tell a Dungeness crab from a rock crab. The Dungeness crab has a rounded shell. It has thick legs and thick pincers. The rock crab is rough. It has saw-tooth like edges on its shell. The rock crab has legs and thin pincers.

8. The ________________________ crab has a rounded shell.

Other kinds of crabs are fished off the north Pacific coast. The king crab is taken in Alaskan waters. Adult king crabs are very large. Crabs with a spread of 4 to 5 feet are seen often. These big crabs can weigh 15 pounds or more. Tanner crabs may reach sizes greater than 2½ feet. When there are fewer King Crabs, the tanner crab will become more important. At present, few of these crabs are harvested commercially.

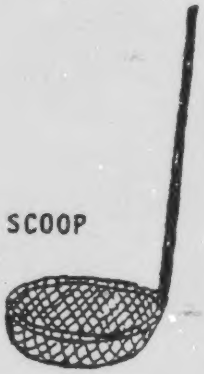
Harvesting Crabs



There are three ways to harvest crabs for sport. The most exciting is, of course, by hand. The scoop and the crab pot are also used.

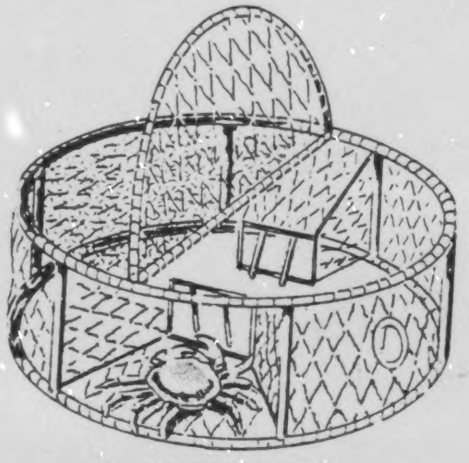
If you wish to catch crabs by hand, it is best to follow the shoreline. Wade through tide pools as the tide goes out. The crab should be held on the shell from the back, use your thumb and fingers. Watch those pincers! Sometimes they can still reach your hand.

A scoop is another way used to catch crabs. A scoop is simply a net tied to the end of an eight to twelve foot pole. The sports crabber drifts along the shoreline in a shallow area. He uses the scoop to catch the crabs and carry them into the boat.



SCOOP

Crab traps or pots are by far the easiest way to catch crabs. This is the method used in commercial crabbing. A crab pot used for sports crabbing may cost from $15 to $50. However, a commercial crab pot will cost about $125. They are made of wire. They have a trap door which keeps the crabs from leaving the pot once they are inside. The traps have a little hole in the side. It lets the small crabs climb out.



CRAB POT

What happens if a crabber loses his crab pot? The crabs in the pot die. They become bait for other crabs. New crabs enter the trap. They also die. This could go on for a long time. A lot of crabs would die. Crabbers do not want this to happen. They make a part of their trap out of screen that rots fast. If the trap is lost, the screen will rot out. The crabs can climb out.

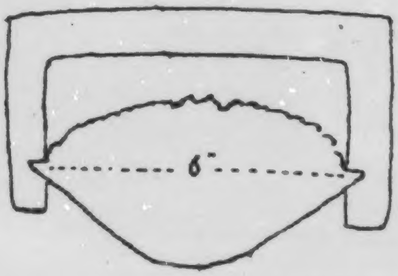
The crab pots are set with fresh bait - herring, smelt, clams, squid or fish eggs. The bait invites the crabs inside. The bait is set in the center of the pot. It is wired down to keep the crabs from reaching it from the outside.

9. Three ways to catch crabs are ______________________________

____and______________________________.

Regulations On Crabs

Commercial fishing has different regulations in different areas at different times. There is one regulation wherever the Dungeness crab is fished. Only male crabs of a certain size shell may be taken. Usually, the shell must be six inches across the back (caliper measure). Crabs which have soft shells are not to be taken. These crabs have just molted. The meat will be soft and stringy. It is against the law to catch crabs for sport using any kind of net gear. Spears are also illegal. Many of these regulations must be followed when commercial crabbing.



A CALIPER MEASURE

The crab pot is baited. It is dropped into the water and left for several hours. The location of each crab pot is marked by a brightly colored buoy. The buoy floats on top of the water.

Commercial crabbers harvest crabs as far as 600 miles off shore. The boats have a small crew. A pilot runs the boat One or two workers help bait and gather the crab pots. The pots are dropped at different depths. They are moved until the crabs are found. Some boats have tanks of sea water. These holding tanks keep the crabs alive until they arrive at the processing plant. Other boats cook the crabs onboard. The crabs are then packed in ice. One boat can watch up to 900 pots. The pots are hauled, baited and reset every one to seven days. The length of time depends on the weather. and the success of the catch. The Marine Weather Bureau gives important information and weather reports.

10. Crab boats fish as far as ______________________________ miles off the coast.

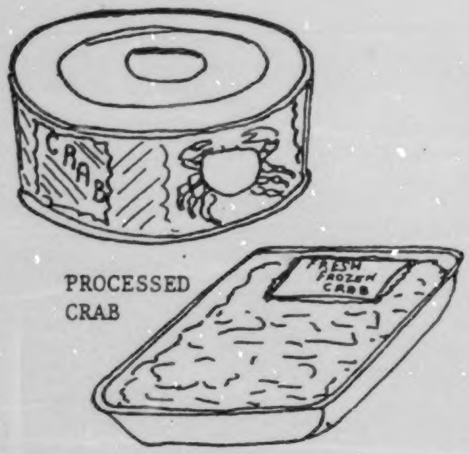
Processing and Marketing the Crab

The crabs are taken to shore processing plants. They are on a dock where it is easy to unload.

Often a leg or pincer is lost from fighting in the crab pot or holding tank. These crabs are usually taken to the cannery. They are cleaned and cooked in large pots. The crabs are cooked in salt water for 15 to 20 minutes. The workers, called "shakers", remove the crab meat from the shells. Some workers are able to "shake" 150 to 200 pounds of meat in one day. This crab meat is then put in cans, sealed and labeled.

11. What do "shakers" do? ______________________________

____



The crabs that were not damaged are boiled, in a different pot. They are chilled in cold fresh water. Many are sent by airplane to the midwest or east coast. Others are sent to restaurants, local fish or seafood markets. These crabs stay fresh for about one week. In some cases the crab's shells are cleaned. This makes them more desirable.

Once the crab meat is canned or frozen, it is trucked to large seafood distribution centers. There are centers, in Tacoma, and Portland. From there they are later sent to markets and restaurants, and you!

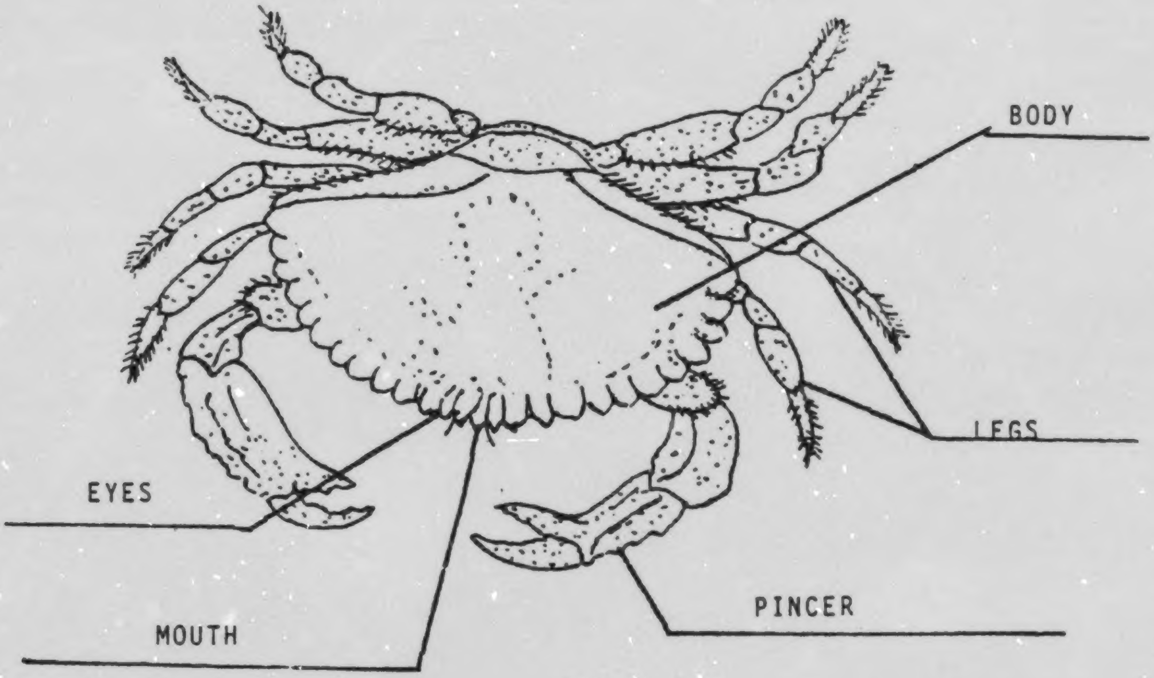
12. Have you ever eaten crab? ______________________________

TEACHER BACKGROUND - Crabs

Students may do this independently or in small groups. The first part of the exercise (labeling the crab) is designed to make the students review the diagrams in the text. The questions test the recall of material from the text.

Duplicate the activity page. One page is recommended per student.

KEY - answers



1. Eyes, legs and pincers all come in pairs.
2. The crab's skeleton is on the outside (an exoskeleton), it is the shell.
3. The crab grows by shedding its skeleton and replacing it with a new one.
4. No, we can't tell the sex from the drawing.
5. To tell the sex, we'd need to turn the crab over and examine the width of the space between the legs. The female has a wider space than the male.

130

KEY WORDS -

body
crab
eyes
label
legs
mouth
pairs
pincer
sex
skeleton
text

TEACHER BACKGROUND - What a Story!

"What a Story" helps develop the sequencing skills necessary to produce good readers. You may elect to have the students do this exercise individually or in small groups. If the class contains many below level readers, the small group method is the preferred choice. The students may then discuss the items and arrive at a common concensus regarding the order.

The statements are directly from the text. Encourage the students to skim to locate the statements and determine the proper order.

The number of statements can be reduced to make this a simpler exercise. Simply cut the statements out and paste the statements retained, along with the directions, on a new sheet of paper. Duplicate the cut and pasted sheet.

Duplicate the activity page. One page is recommended per student.

Discuss the results with the class. Help develop logical thinking patterns in the students. For example: The meat would have to be removed from the shell before it was eaten.

WHAT A STORY - TEACHER KEY

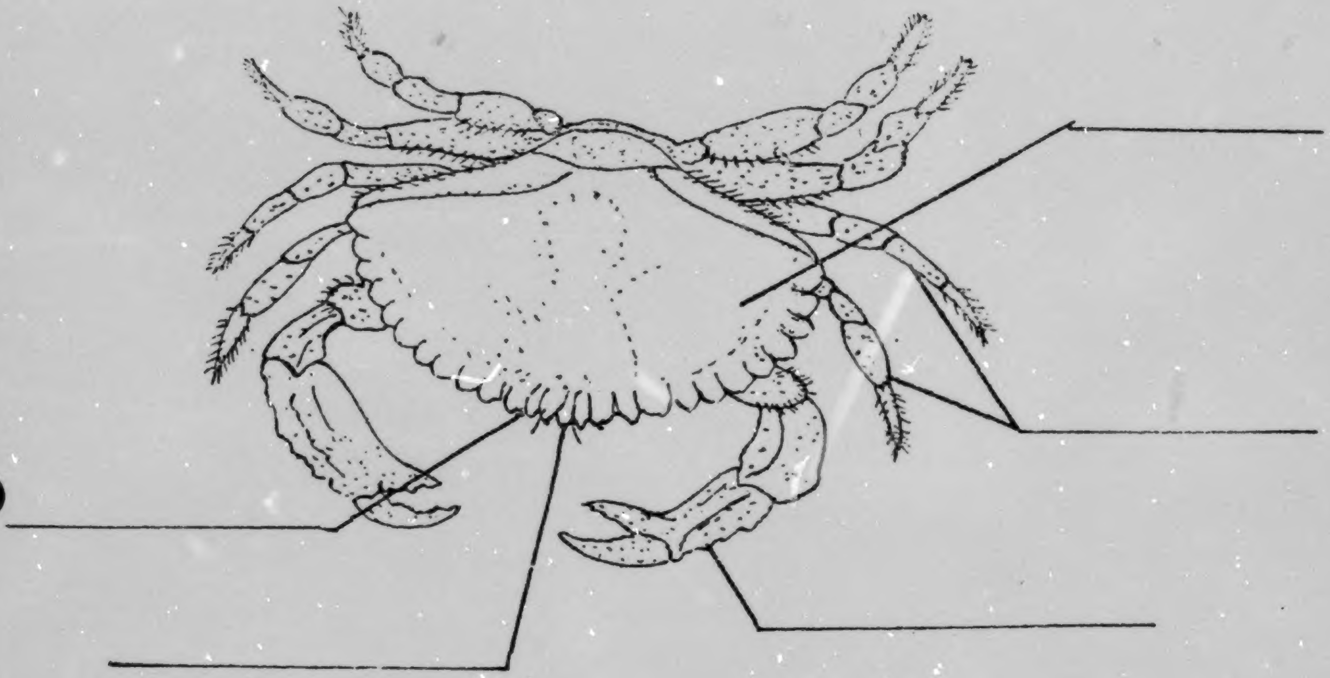
3
1
10
7
2
8
4
9
6
5

KEY WORDS

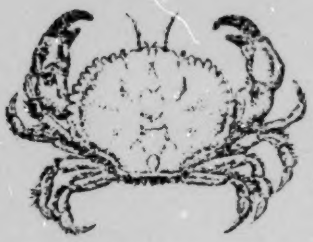
clippings
collision
pressroom
reporter
stomach

CRABS

Use the drawings in the text to label the marked parts on the crab shown below.



1. What are two labeled parts that come in pairs? ______________________________
2. Where is the crab's skeleton?
3. How does this crab grow?
4. Can we tell the sex of this crab from the drawing?
5. How could we tell the sex of this crab?



WHAT A STORY!

Kenny Nimbletoes, boy reporter, was on his way to the pressroom. He was carrying all the clippings for a feature story on "Your Friend the Crab" Well, what should happen to Kenny? He had a collision with a fellow reporter. All of Kenny's clippings fell to the floor. The story below is the result. Help Kenny arrange the facts. KEEP KENNY FROM LOSING HIS JOB AT THE DAILY PLANET.

Number the statements in the correct order from crab egg to crab dinner.

_______As crabs grow their shell does not grow with them. Therefore once or twice a year they must shed the old or too small shell.

______The mother crab carries her eggs on her stomach in a big mass.

______Your crab salad is ready to eat!

______Shakers clean the meat from the shells.

______The eggs hatch into a free swimming larva.

______The crab meat is put into cans.

______Fisherman Frank sets his crab pots.

______The crab is taken to your neighborhood store by truck.

______The crabs are placed in large tanks to cook.

______The crabs are placed in tanks with running sea water.

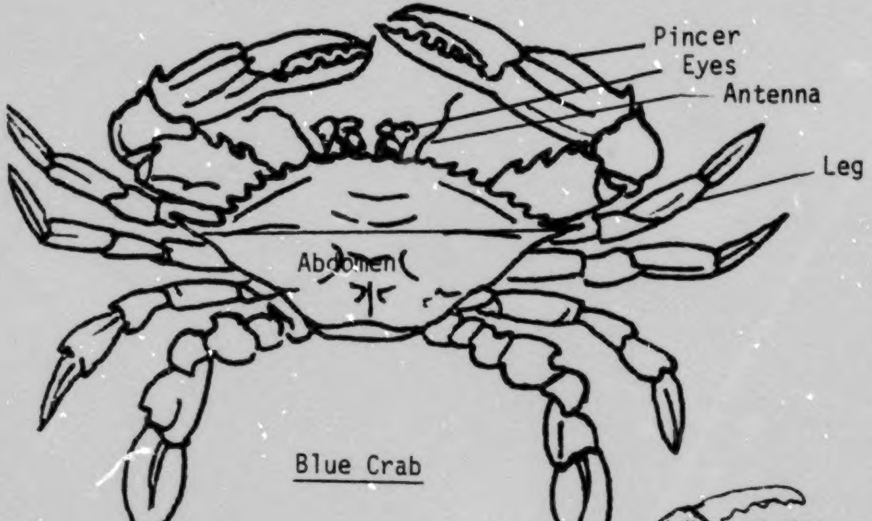
TEACHER BACKGROUND - Stuffed Crab

This is a fun activity that can add interest to your room while teaching something about crab anatomy. As the children make their crabs, utilize the opportunities that arise to relate structure (eg. pincers) to function (catching food, etc.)

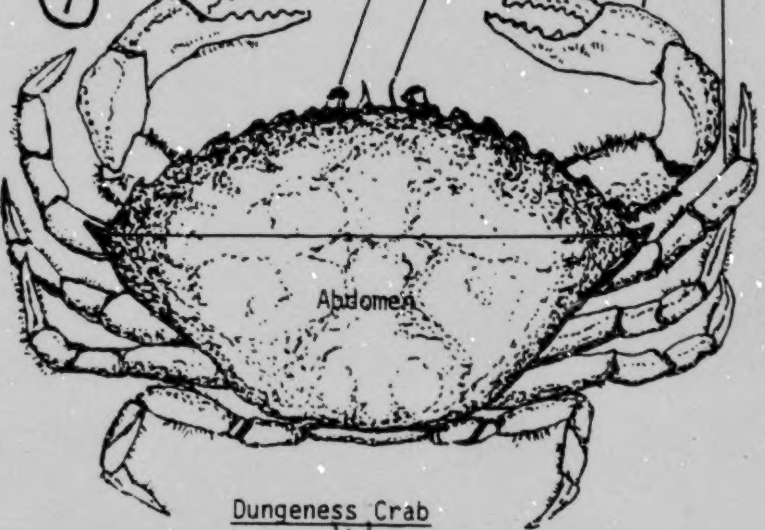
An overhead transparency master is included. You may wish to borrow several Overhead Projectors so that several students may make their drawings simultaneously.

KEY

A labeled crab is shown below.


Pincer
Eyes
Antenna
Leg
Abdomen

Blue Crab


Eyes
Antenna
Pincer
Leg
Abdomen

Dungeness Crab

Key - Questions to think about:

1. Crabs use their walking legs to move.
2. Crabs molt (shed their shell) to grow.
3. Carefully pick up any crab by reaching across the back.
4. You should always replace any rocks you turn over at the beach. The animals and plants living underneath would likely die if the rock was not returned to its original location.

STUFFED CRAB

Now that you know about crabs, let's make one! Here are the things you will need.

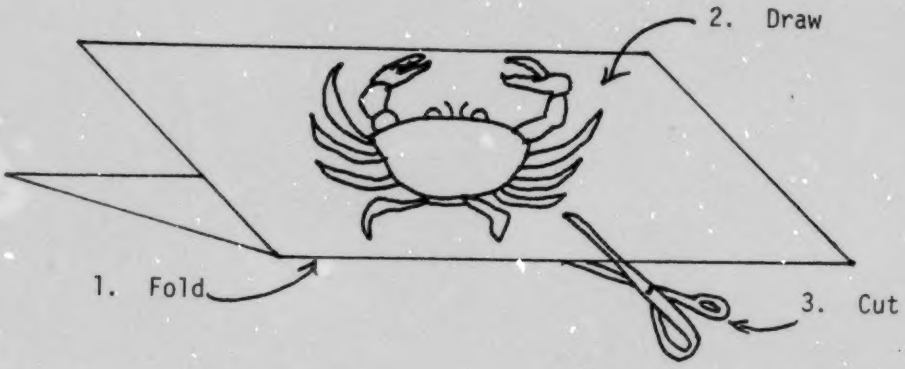
Materials:

- paper - butcher or construction
- paper - waste or newspaper
- crayons or paint
- stapler
- string
- scissors

Here is how you do it.

Procedure:

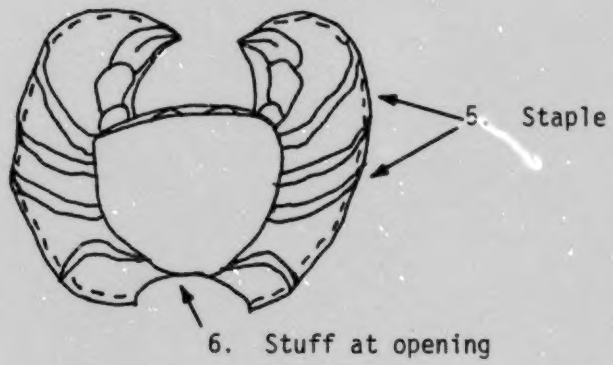
1. Fold your piece of paper in half (either lengthwise or widthwise).
2. On one side of the folded paper, make a drawing of your favorite crab. Follow your teacher's directions for using the overhead projector.
3. Start at fold and cut out the crab. Cut both sides of the folded paper at once. You will have two crabs when you have finished.



4. Add the following information to your crab:
    a. Label each pincher (write the word "pincher" on your drawing's pincher).
    b. Label one crab leg.
    c. Label the abdomen.
    d. Draw a straight line across the spot where you would measure caliper width. How wide is your crab in inches?
    e. Write the kind of crab you have made in large letters along the caliper width line you've just drawn.
    e. Use your pencil to add eyes and antenna.

5. Staple the two pieces together around edge of crab. Be sure to leave an opening.

6. Stuff crab with waste paper or newspaper.



7. Staple opening.
8. Hang by string.
9. Enjoy your creation.

Questions to think about:

1. How do crabs move?
2. How can they grow with a hard shell?
3. How should you pick up a live crab?
4. One way to find crabs is to turn over rocks. Why should you replace the rock?

TEACHER BACKGROUND - Observing the Living Crab

This is a lab exercise involving one or two hours. It may be done over two days. The crab is an ideal laboratory specimen in most areas because:

1. It is easy to keep alive and is relatively available.
2. It is large enough so that the various parts can be seen without the aid of a microscope.
3. It shows outstanding specialization of appendages. Form and function can be easily related.
4. If you choose the right kind of crab, you can have a very nice dinner after the exercise is completed!

WHERE TO GET CRABS

If you live near the coast you can probably collect your own crabs. Shore crabs are easily obtained by turning over rocks at low tide (please turn all rocks back to their original position). With a little work Dungeness or rock crabs can be taken with a scoop or crab pot. Be sure to check local regulations for size and number limits and for season length. Crabs may also be obtained from fish wholesalers, a live crab is best but a frozen crab will allow much of the exercise to be completed. Biological supply houses also supply live crabs at a reasonable cost. For example: Carolina Biological Supply, 2700 York Road, Burlington, North Carolina 27215. Pet Shops often sell hermit crabs for pets. Most of the exercise could be completed using hermit crabs.

Cautions: Crabs need to be kept moist. They can be entirely submerged in salt water, but they will also do well if they are partly submerged. Crabs have a rather strong grip. Avoid being gripped! Grasp the crab across the back. Watch the action of the pincers. A preview of crab handling is recommended before doing this exercise with your class.

This exercise may be done as a demonstration or as a small group activity. Groups of three or four students is ideal. If student groups perform the activity, it is best to use small shore crabs. Demonstrate the proper handling methods to the students and observe the handling carefully.

KEY

1. Answers to this and following questions depend upon observation. Crabs walk sideways using specialized walking legs.
2. Generally crabs have 10 appendages.
3. Some species swim quite well. Others barely at all.
4. Usually all appendage except for those bearing the pincers.
5. Answers depend upon the particular crabs.
6. Most crabs dig using their back legs.
7. Crabs catch live food with their pincers.
8. Pincers also serve to move food to mouth.
9. Close observation should show where water enters gill chamber.

10.-15. Answers will vary depending upon crabs observed by class.

17. Most crabs can hold up entire weight with one pincer.
18. Few students can lift themselves up with one arm.
19. Pound for pound crabs are stronger then fourth graders!

KEY WORDS

abdomen

antennae

appendages

aquarium

average

caliper width

gill chamber

habitat

pincers

stalks

structures

survive

swimmerets

weight

OBSERVING THE LIVING CRAB

The crab is a very interesting creature. Carefully watch this animal. How do its body structures help it to survive in its habitat.

Watch a live crab in an aquarium.

1. How does the crab move?____________________
2. How many appendages (legs, etc.) does the crab have?__________
3. Can the crab swim?____________________
4. What appendages does the crab use in walking?__________
5. Are any of the crabs forming new appendages?__________
6. How does the crab dig in the sand?____________________
7. How does the crab catch live food?____________________
8. What appendages are used in getting food to the mouth?__________
9. Can you see where water enters the gill chamber?__________

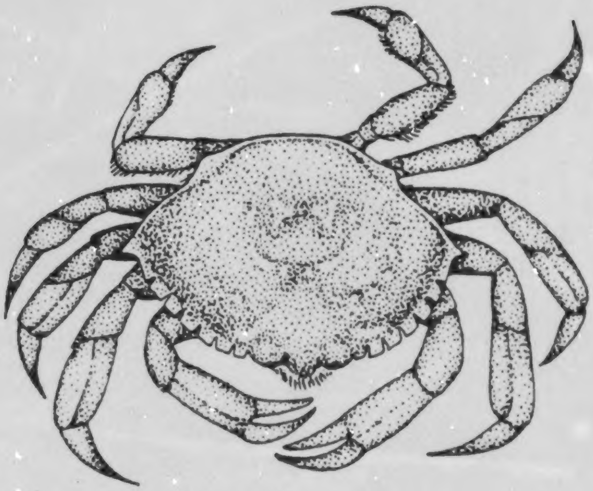
Use your drawing of the crab to help you find the following:

The eyes on stalks

The heavy pair of pincers

The four pairs of walking legs

Lift up the abdomen and observe the feather-like appendages called swimmerets.



Dungeness Crab

10. Look at the shape of the abdomen. What sex is your crab. ______

11. Can you find the antennae that are near the eyes? ______________

12. How wide is your crab (caliper width)? ______________________

13. How wide is the widest crab in the class? ____________________

14. How wide is the narrowest crab in the class? __________________

15. Estimate (make an educated guess) the width of the average crab.
(A crab about halfway in-between the biggest and smallest).

16. Find the true average. Do the Following:

a) add all of the widths.

b) divide by the number of crabs measured.

Your answer is the average.

See how powerful your crab's pincers are DO NOT PUT YOUR FINGER IN-BETWEEN THEM. Place your pencil in between the pincers. Try to lift up the crab using your pencil. Be careful not to lift the crab too high. You only need to see if he is powerful enough to lift his own weight.

17. Can your crab hold up his own weight with one pincer?

____

18. Can you lift yourself up from the ground with only one arm?

____

19. Pound for pound, who do you think is stronger?

____

TEACHER BACKGROUND - Scrambled Crab

"Scrambled Crab" is an exercise which stresses vocabulary skills. The definitions are found in the text. The words scrambled are underlined key words.

This exercise may be completed individually or by small groups with discussion. Students respond to challenges and this exercise can be easily used to increase the students' problem solving abilities. A brief discussion of the correct results at the end of the exercise is recommended to reinforce the learning which has occurred.

SCRAMBLED CRAB - KEY

LOMTING	A crab's shell does not grow with the crab. The crab sheds its old shell in a process called	MOLTING
SRECNIP	Crabs use these to tear food into smaller pieces.	PINCERS
KALPNONT	Crabs first hatch into crab larva. They are free drifting animals called	PLANKTON
BRAC TOPS	Commercial fishermen use these to catch crabs.	CRAB POTS
DIANNIS	These people harvested crabs long before European man arrived in the Pacific Northwest.	INDIANS
OYUB	This brightly colored float marks the location of a crab pot.	BUOY
RAKEHSS	These workers remove crab meat from the shells.	SHAKERS

KEY WORDS

buoy

commercial fishermen

crab larva

crab pots

European man

harvested

Indians

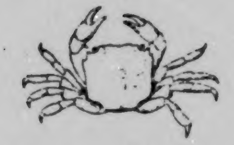
location

molting

pincers

plankton

shakers



SCRAMBLED CRAB

Below you will find definitions of words used in the section on crabs. The letters of the word defined are also given. The letters are not in the right order. Your task is to unscramble the words.

Example: BRAC the animal this section is about Crab

LOMTING	A crab's shell does not grow with the crab. The crab sheds its old shell in a process called	________
SRECNIP	Crabs use these to tear food into smaller pieces	________
KALPNONT	Crabs first hatch into crab larva. They are free drifting animals called	________
BRAC TOPS	Commercial fishermen use these to catch crabs.	________
DIANNIS	These people harvested crabs long before European man arrived in the Pacific Northwest.	________
OYUB	This brightly colored float marks the location of a crab pot.	________
RAKEHSS	These workers remove crab meat from the shells.	________

SUGGESTED ADDITIONAL ACTIVITIES

1. Observe crab larva or eggs under the microscope.
2. Draw a crab and label its parts including the legs, pincers, eyes and body.
3. Study various crabs and identify whether they are male or female.
4. Draw a picture of the life cycle of a crab from egg to adult.
5. Observe the crab in an aquarium. Note how it moves.
6. Draw a Dungeness crab or a rock crab.
7. Write a report on other types of crabs.
8. Draw pictures of other types of crabs.
9. See the filmstrip "Crab Cannery".
10. Cook and clean a fresh crab.
11. Visit a crab cannery.
12. Make a small picture booklet on the steps in processing crabs at the cannery.
13. Visit a local seafood market.

HARVESTING CLAMS

TEACHER BACKGROUND - Harvesting Clams

Please read through the text and activities before beginning the section on clams.

A source of clams in the shell needs to be discovered. Local fish markets can help if you are not able to dig your own. Try to avoid the temptation to skip the hands-on activities like "Open Sesame". These activities provide valuable teaching moments that are well worth the advanced planning required. Please consult the "Teacher Background" sections for each activity prior to having your class do the activity.

Duplicate the text and activity pages. One set is recommended per student.

KEY

1. Clams best eaten in chowder include:
    a. butter clams
    b. cockles
2. The clams best eaten whole with butter on: steamers or little necks
3. The largest clams are: a. geoducks
    b. horse clams
4. Clam beds are clusters or families of clams found along the beach.
5. Clams are hard to catch because they live below the surface and can dig rapidly downward as you search for them.
6. Geoducks are not harvested by dredge because they lie very far below the surface of the water and deep in the sand.
7. Geoducks are harvested by SCUBA divers using powerful water hoses.
8. Many of your students will have had clams in chowder or other meals.

KEY WORDS - Clams

beds (clam)
butter clam
cannery
chowder
clams
cobble beaches
cockle
conveyor belt
dredge
geoduck
grooves
habitat
harvested
horse clam
little neck clam
low tide
razor clam
shellmounds
siphon
steamers

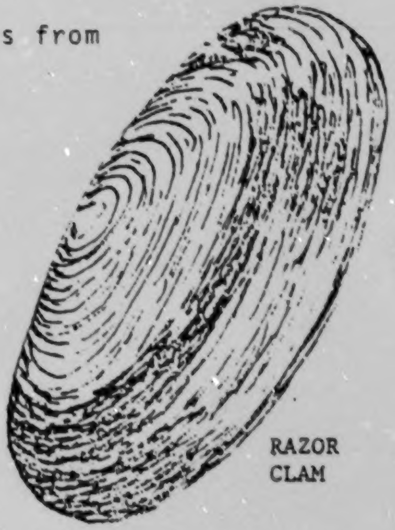
HARVESTING CLAMS

Man has used clams for food for thousands of years. Indian people living on the shoreline were very good clam diggers. We can today see huge piles of clam shells called shellmounds. They are the remains of the clams eaten over a long time.

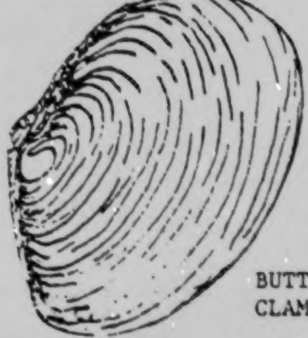
Types of Clams

There are many kinds of clams that we can eat. In the Pacific Northwest the most popular are the razor clam, butter clam, little neck, cockle, horse clam and geoduck (goo-e-duk).

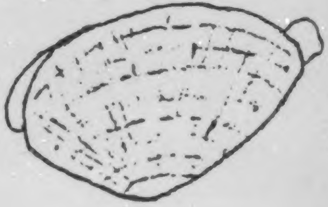
The razor clam is found on the ocean beaches from Alaska to California. It has black markings around the edge of its shell. The edge of a razor clam is very sharp. The razor clam can be as large as six to eight inches. (15-20cm) Some people rate it as the best clam for eating.


RAZOR CLAM

The butter clam is white. It is three inches (8cm) in length when full grown. They are found from Alaska to California. Butterclams are commercially harvested in Washington. They can be found on many of our beaches. Butter clams are cut up and used in clam chowder.

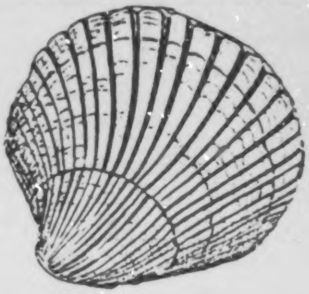

BUTTER CLAM

The steamers or little necks are often found on muddy beaches. They are about 1½ (4cm) inches long and are white. They are very tasty. Many people steam them. Then they dip them in butter and eat them whole.



LITTLE NECK CLAM

The cockle is also found in the Pacific Northwest. The cockle is not harvested commercially. It is darker in color and has small grooves on the shell from front to back. Some people like it ground up in chowder.



COCKLE

1. Which clams are best eaten in chowder?

   a) ______________________________

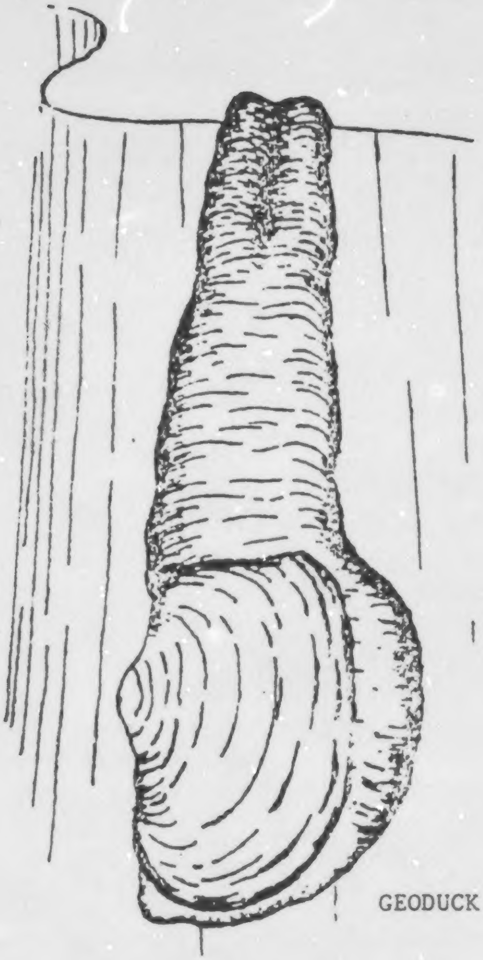
   b) ______________________________

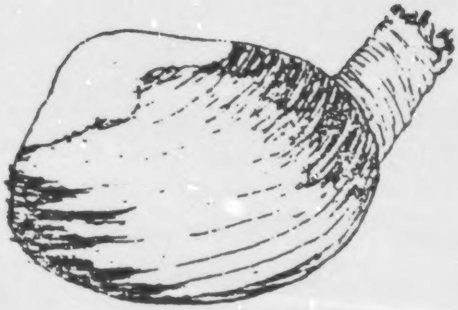
2. Which clam is eaten whole with butter? ______________________________

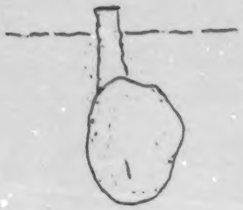
   ____

The two largest clams are the geoduck and the horse clam. The horse clam is not as well liked as the other clams. It is tough and the taste is sweet. The horse clam is not harvested commercially. It has black on the edges of its shell and its siphon (neck). The geoduck has tan edges. It is more rectangular in shape. The geoduck cannot close its shell tightly. Its siphon is so large that it will not fit in the shell. It lives from two to six feet below the surface of the sea floor at depths of 10 to 120 feet. The geoduck is commercially harvested in Puget Sound and Hood Canal.

3. The largest clams are a) ________________________________
and b) ________________________________


GEODUCK


HORSE CLAM



Where To Find Clams

Puget Sound is known for its good clam digging. Clams are found in small beds (clusters or families of clams along the beach. 1. The best clam digging is at low tide. Not all beaches are the same. Differences in the beach habitat (the place where a clam lives) cause differences in the types of clams found. Rocky beaches are good for oyster growth. However, they are poor habitats for clams. Butter clams and little neck clams like to live in gravel and cobble beaches. Sand and mud beaches are the favorite habitats for geoducks, horse clams and cockles.

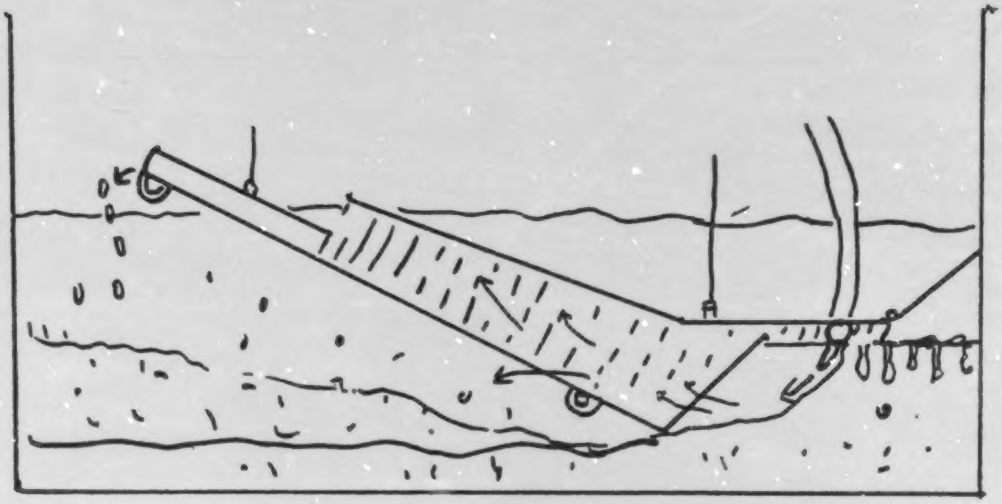
4. Clam beds are ____

Harvesting Clams

Once a likely spot has been found, the harvesting of the clams can begin. Most of the clams named above can be dug with a shovel at low tide. Some clams live very near the surface of the sand. Others may lie in the sand as deep as three feet or more. You can find their hideouts. Look for the squirt holes where the clams are feeding. Have you ever dug for clams? If you have, you know that clams are hard to catch. Many more clams vanish in the mud than you are able to catch. This is because most clams can dig rapidly through the sand.

5. Clams are hard to catch because ________________________________

Most clam diggers eat all of their own harvest. Yet, there is a large commercial clamming industry. Most commercial harvesting of butter clams is done with a dredge. A dredge washes the clams from the bottom with strong jets of water. It then carries them onto a conveyor belt that brings them to the surface. The men with the dredge sort out the clams they want. The rest are returned to the water.



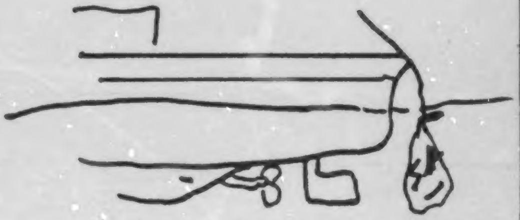
A CLAM DREDGE

There is another way to harvest clams by boat. A six foot mesh bucket is dropped overboard. It is dragged along the ocean bottom. The bucket is then brought into the boat. The clams are sorted by size.

Geoducks are harder to harvest. They lie very far below the surface to the water. Divers wearing special suits, to keep warm, dig the geoducks underwater. The diver can find the clam because its neck sticks way out. He grabs the geoduck's neck and uses a powerful water hose to loosen the soil around it. The geoducks are placed in a sack and lifted to the surface. Divers can dig over two geoducks per minute. However they can only stay underwater from one to three hours at a time.

Another person stays on board the boat. She communicates with the divers. She also helps raise the bags of geoducks. Geoducks can be harvested all year. A license is needed to commercially harvest clams.

6. Why aren't geoducks harvested by dredge?______________________
____



A BAG OF GEODUCKS BEING LIFTE
TO THE SURFACE

7. How are geoducks harvested?
____
____

Marketing the Clam

Harvesting the clams is only the beginning for the commercial clam digger. He must find a way to prepare the clams and get them to you. After the clams are harvested, some are taken to a cannery, others are sold directly to a market.

Men and women work at many different jobs in the cannery. The first job is to sort the clams. The clams are then cleaned. Some of the clams are now ready to be sold in their shells. The rest of the clams are cooked. They are dipped in boiling water. The boiling water makes the clams open. After they cool, the meat is removed from the shells. Cannery workers freeze or can and label the clams for market. The clams are then loaded onto trucks. The truck drivers take them to small seafood markets or big seafood distribution plants. There the clams are readied for shipment. They are shipped by truck, boat, air or train to places all over the world.

When fresh clams arrive at the market, they are put into refrigerated display cases. They can be kept for about one week. Frozen clams can be kept for a few months. They lose some flavor when frozen, for a long time.

When a seafood market or restaurant needs more clams they can order from their distribution center. They can also order directly from the cannery or from a local clam digger.

The next time you are in your grocery store, look for clams for sale. You might find them in several places. Look in the meat department for fresh clams. Look in the canned food section for canned clams. Look in the frozen food section for prepared clams. What kinds of clams can you find? Where did these clams come from?

8. Have you ever eaten clams?________________________________

____

TEACHER BACKGROUND - Gooey Ducks?

"Gooey Ducks?" highlights an unusual clam, the giant geoduck (pronounced "gooey duck" or "gwe duc"). This activity is designed to get your students thinking about the numbers involved in harvesting marine animals to supply food and the impact that harvesting can have on the animal population. The relatively simple mathematics required is presented in a step-wise fashion to help your students solve these word problems. It is possible that some of your students will need assistance in the setting up of the solutions.

Geoducks are the world's largest temperate water clam. They are found in sand or mud in intertidal areas below the zero tide level. Most geoducks are found below the tidal zone in Puget Sound. The Washington State Department of Natural Resources manages the somewhat controversial geoduck fishery. Prior to 1969, the geoduck was a sport clam only. The controversy pits commercial interests against sport clammers. Other groups worry about overharvesting by either group. Geoducks are harvested by teams of divers using hand-held water jets which temporarily liquify the sand or mud bottom. The divers then can pull the geoducks out of the sand by the neck. Opponents claim these high pressure water jets leave the bottom a virtual "biological desert". Proponents, on the other hand, claim "harvesting causes little disturbance on the sea floor. Only a small hole is left where the geoduck was removed."

When it comes to eating, geoducks are considered a delicacy by many. Most geoduck necks, comprising 50 percent of the weight of the clam, are sent to Japan. The remainder is used by the domestic market in clam steaks and chowder.

Duplicate the activity pages. One set is recommended per student. While this activity may be accomplished by individual students, there is some merit in having your students work in pairs on this assignment. The members of a pair can help each other work through the thought processes involved in deriving the solutions. Circulate through the room to aid students in need of your help. Plan to devote a few minutes to go over the correct answers.

KEY

1. A geoduck is a large clam. Geoducks are the world's largest non-tropical clams.

2. Geoducks thrive in the sandy bottoms found under much of Washington's Puget Sound.

3. a. 165 million pounds of geoducks can be managed for harvesting.
   b. 5 million pounds of geoducks can be harvested per year.
   c. At the rate of 5 million pounds of geoducks per year, it would take 33 years for all of the geoducks to be harvested. ie:

$$\frac{\text{165 million pounds of geoduck available to harvest}}{\text{5 million pounds of geoduck harvested per year}} = \text{33 years.}$$

It is worth discussing the assumptions made in these questions, namely that the geoducks stop reproducing and none die. Neither assumption makes much sense in the natural world. For this exercise, one assumption stops the population from increasing while the other stops it from decreasing except through harvesting. Perhaps, we can consider them to balance each other out. These assumptions are what scientists and planners use to make a model. A model represents a real situation and can be used to study the effect of changes.

4. a. One diver can harvest up to 2000 pounds of geoduck a day.
   b. One diver can harvest up to 10,000 pounds of geoduck in a 5 day

work week (ie. 2000 pounds/day x 5 days = 10,000 pounds)

c. One diver can harvest up to 500,000 pounds of geoduck in a 50 week year (ie. 10,000 pounds/week x 50 weeks = 500,000 pounds).

d. At the rate found in (c) it would take 10 divers to harvest the 5 million pounds of geoduck allowed by the State of Washington (ie. 5,000,000 pounds of geoduck/500,000 pounds of geoduck per diver = 10 divers).

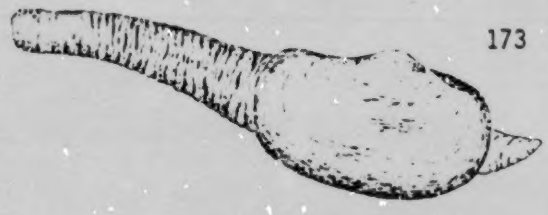
5. a. It takes about six years for a geoduck to reach two pounds.

b. Geoducks can live to be 130 years old.

c. If the geoduck grew at a rate of two pounds per 5 years, it would weigh 40 pounds at 100 years (ie. 100 years/5 years x 2 pounds per 5 years = 40 pounds).

d. Since the largest geoducks known weigh about 13 pounds, it does not seem likely that geoducks grow the same amount each year of their lives.

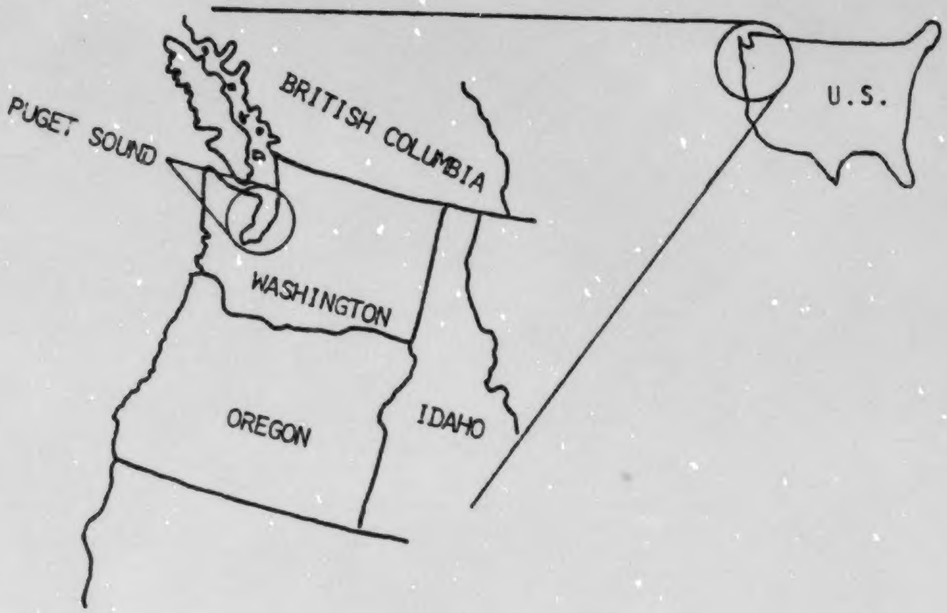
KEY WORDS
assume
geoduck
harvest
manage
population
rate
reproducing
thrive
tropical



GOOEY DUCKS?

Gooey Ducks? Oil coated birds? Actually, "gooey ducks" (spelled "geoducks") are not birds at all. Geoducks are the world's largest non-tropical clams. These giant clams usually weigh two to five pounds. The heaviest geoducks can weigh up to 13 pounds!

Geoduck harvesting has become a large fishery. It is the largest clam fishery on the Pacific Coast of North America. These giant clams thrive in sandy bottoms. Such bottoms are found under much of Washington's Puget Sound.



1. What is a geoduck?

2. Where is one place which geoducks thrive?

Here are some geoduck facts:

- * 165 million pounds of geoduck can be managed for harvesting in Puget Sound.
- * 5 million pounds of geoduck per year can be harvested.
- * Geoduck divers can dig a geoduck every 15 to 30 seconds. They can harvest up to 2,000 pounds a day.
- * It takes about six years for a geoduck to reach two pounds.
- * Geoducks can live to be 130 years old.

3. Let's assume all the geoducks alive now stay alive. Also assume that no new geoducks are added to the population. The population of geoducks will then remain the same size.

a. How many pounds of geoducks can be managed for harvesting?

__________ million pounds.

b. How many pounds of geoducks can be harvested per year?

__________ million pounds.

c. In how many years could all of the pounds of geoduck be harvested? Please show your work.

Hint: Assume we have ten pounds of geoduck available to harvest. We harvested 2 pounds per year. At this rate, it would take 5 years to harvest all of the geoducks. In other words:

$$\frac{\text{10 pounds of geoduck available to harvest}}{\text{2 pounds of geoduck harvested per year}} = \text{5 years to harvest all geoducks}$$

4. a. How many pounds of geoducks can one diver harvest a day?

__________ pounds a day.

b. How many pounds can one diver harvest in a 5 day work week?

__________ pounds in a week.

c. How many pounds can one diver harvest in a 50 week work year?

__________ pounds in a year.

d. Assume the yearly rate of harvest you found in (c). How many divers would it take to harvest 5 million pounds of geoduck?

_______ divers.

5. a. How long does it take for a geoduck to reach two pounds?

______ years.

b. How long can geoducks live?

_______ years.

c. A particularly quick growing geoduck reached two pounds in 5 years. This geoduck grew at the same rate to an age of 100 years. How much did it weigh?

______ pounds at 100 years.

d. Think about your answer in (c). Do you think geoducks grow the same amount each year of their lives?

yes/no (circle your answer)

How did you reach your conclusion?

TEACHER BACKGROUND - Insides out

"Insides Out" gives your students an opportunity to put together a model of a living clam while learning something about clam anatomy and physiology. This is a fun activity and may be used as a good prelude to or in lieu of "Open Sesame".

The activity provides some information about the structures found inside the living clam and about how those structures function. In addition to the items mentioned, consider pointing out the growth lines on the shell, the places for the attachment of the two muscles which close and open the valves, and the mantle which is the soft part of the shell which secretes the hard shell. A good source for additional information about clam anatomy is:

> Barnes, Robert D., 1980; Invertebrate Zoology.
> W.B. Saunders Company.

Duplicate the activity pages. One set is recommended per student. Note that the pages must be duplicated front to back for the clam to unfold properly. It is important that your students follow the directions in the procedure section in the order given and that they answer the questions as they procede. Provide time for a discussion of the activity and the questions as a follow-up. Consider displaying your students' clams by punching a hole in one of the shells and hanging them by a string through the hole.

KEY

The clam drawings are taken from "Ocean Study Activities K-5", a science curriculum supplement of Alamance County Schools; Graham, North Carolina.

4. b. Although clams live in the sand or mud, they feed by extending their siphons upward into the water column. They pull water containing food and oxygen down into their gills. They can quickly retract their siphon for protection from predators.

4. d. Although clams are able to feed without much use of their foot, they need to move away from predators and may need to relocate themselves as their surroundings change from pollution, erosion, water flow changes, etc.

5. b. This questions refers your students back to the introduction. Clams feed on tiny food particles floating in the water including plankton, in this case tiny, free-floating plants and animals.

KEY WORDS
adductor muscles
carbon dioxide
elongated
excurrent siphon
gills
hinges
incurrent siphon
lengthwise
oxygen
particle
plankton
record
siphon
valves

INSIDES OUT

Clams are found in shallow waters all over the world. There are about 20,000 different kinds of clams. All of them may be eaten. Even so, only about 50 varieties are commercially harvested. Clams may be round, oval, elongated, or almost rectangular.

Clams feed on tiny food particles floating in the water. Some of these particles are actually tiny plants and animals. These tiny plants and animals are called plankton. Clams take in the water and food through their siphons. They strain out the tiny food with their gills. Just what and where are the siphon and gills? In the following activity you'll learn about these and other clam parts.

MATERIALS - Here's What You'll Need...

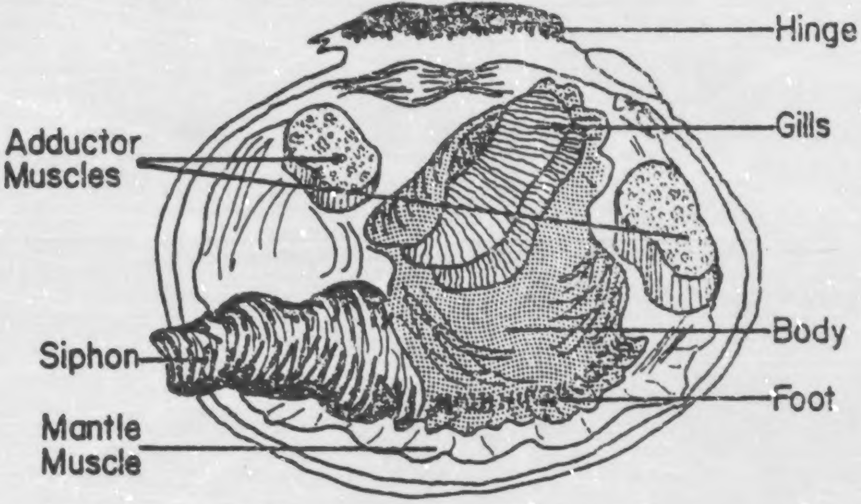
- clam sheets
- scissors
- stapler
- crayons or felt tips

PROCEDURE - Here's What You'll Need...

1. Obtain two clam sheets and a pair of scissors.

2. Look carefully at the clams drawn on your sheets. Notice that the drawings are really in pairs. The pairs are front and back views. The arrows point toward letters. The letters will tell you how to put the drawings together. With a pencil, circle the letters from A to F.

3. The drawing below shows an open clam.



Use the drawing to answer the following questions:

   a. On the "B" side of drawing I, color the adductor muscles. Record the color you used in this space ______________
   b. The two shells are called valves. On the outside of one of the valves, print: VALVE.
   c. Cut out drawing I. Follow the outline carefully.

4. Find drawing II. Answer the following questions:

   a. On the "C" side of your drawing, color the two siphons. Record the color you used in this space ______________
   b. One siphon sucks water into the clam. This is called the incurrent siphon. It brings in water which carries food and oxygen. The other siphon pushs water out of the clam. This water carries wastes and carbon dioxide. The second siphon is called the excurrent siphon. How might a clam feed when its body is buried in the sand?

c. On the "D" side, find the foot. Print the word "FOOT" on the foot. Hint: the foot is rather G-shaped. It is opposite the hinge joining the valves.

d. The foot is a strong muscle. It can stretch out and push or pull the clam about. The clam feeds by pulling water containing food to it. It doesn't have to chase and catch its food. Even so, why might the clam to be able to move about?

e. Cut out drawing II.

5. Find drawing III. This drawing shows the internal organs of the clam. This shows the clam's body cut down the middle lengthwise. Answer the following questions:

a. On the "E" side color the gills. Record the color you used in this space ________________

b. The gills do two important things. They absorb oxygen and release carbon dioxide. They also catch food particles. Afterwards they move the food to the clam's mouth. What do clams eat?

c. Find the "F" side. Color the adductor muscles and the gills. Use the same colors you used before to color these parts. Again, record the colors you used: gills ____________
adductor muscles ____________

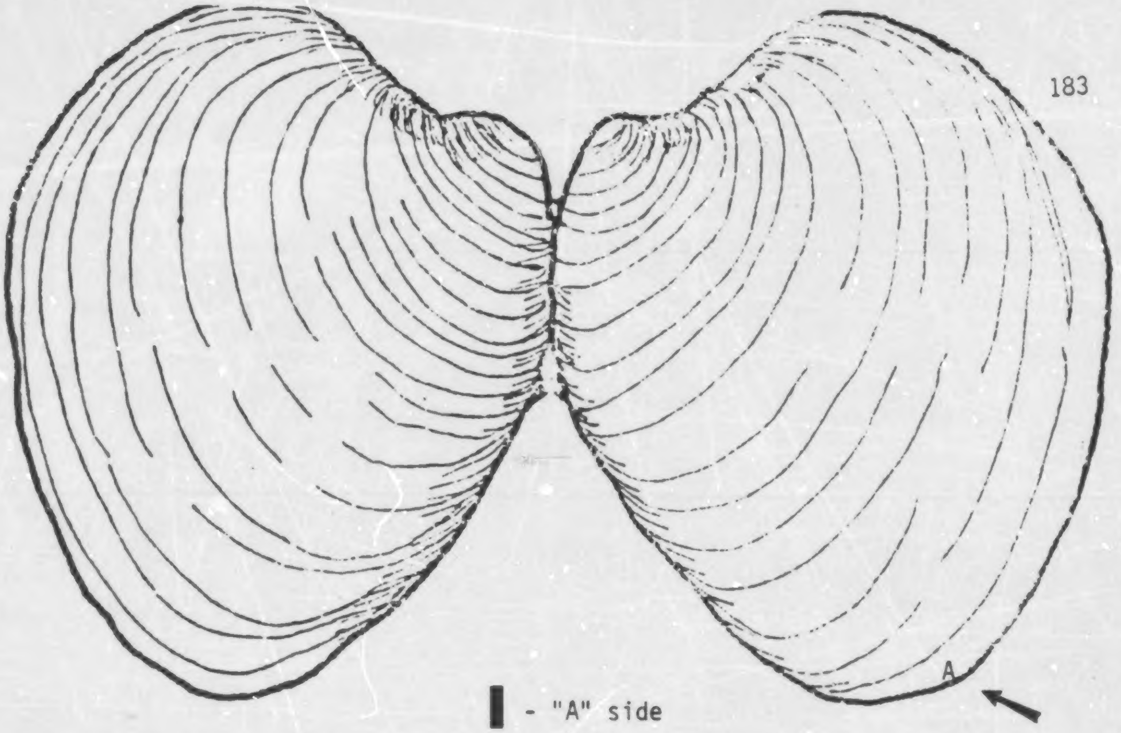
d. Cut out drawing III.

6. Place drawing I down on the table. Have the "B" side up.

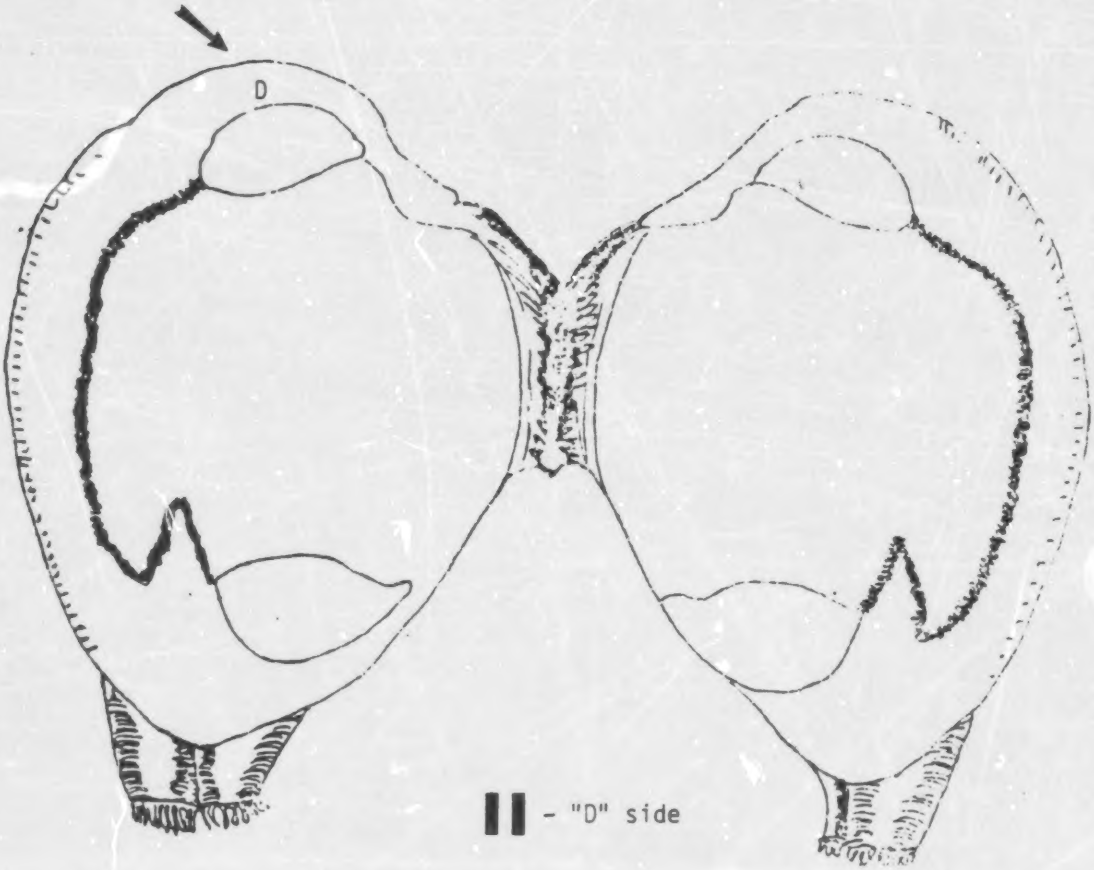
7. Place drawing II on top of drawing I. Have the "D" side up.

8. Place drawing III on top of drawings I and II. Have the "F" side up.

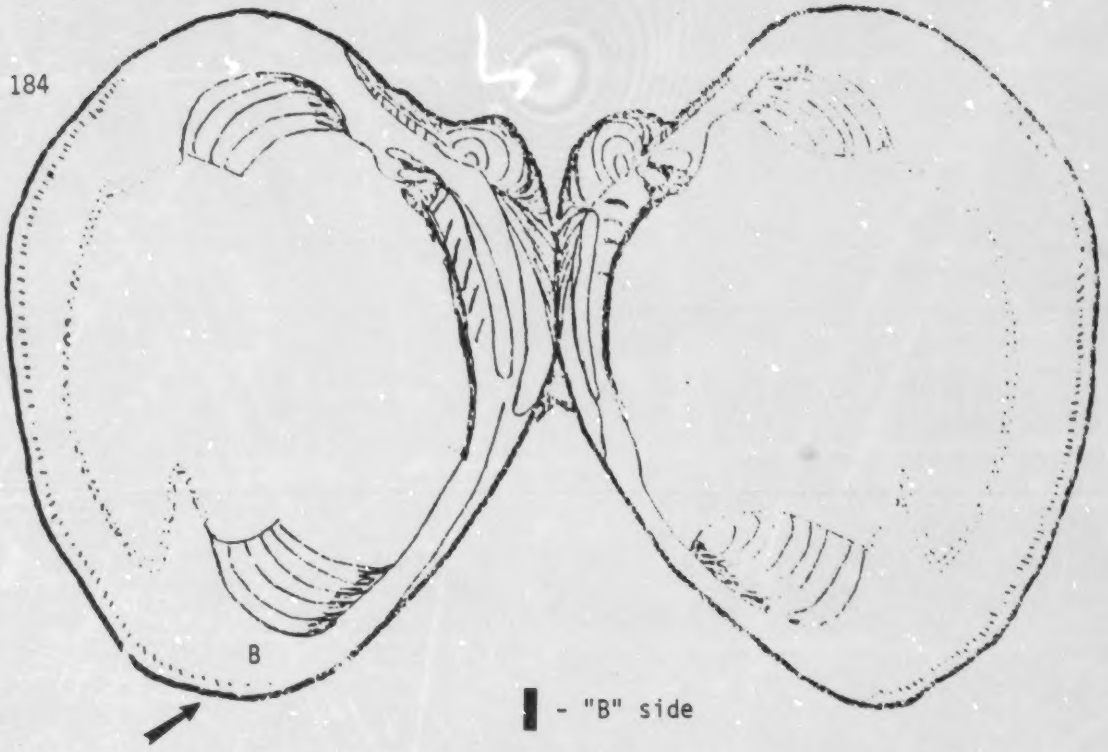
9. Make sure your hinges line up. Fold the three drawings along the hinge line. Staple the folded drawings together at the hinge line. Enjoy your paper clam.



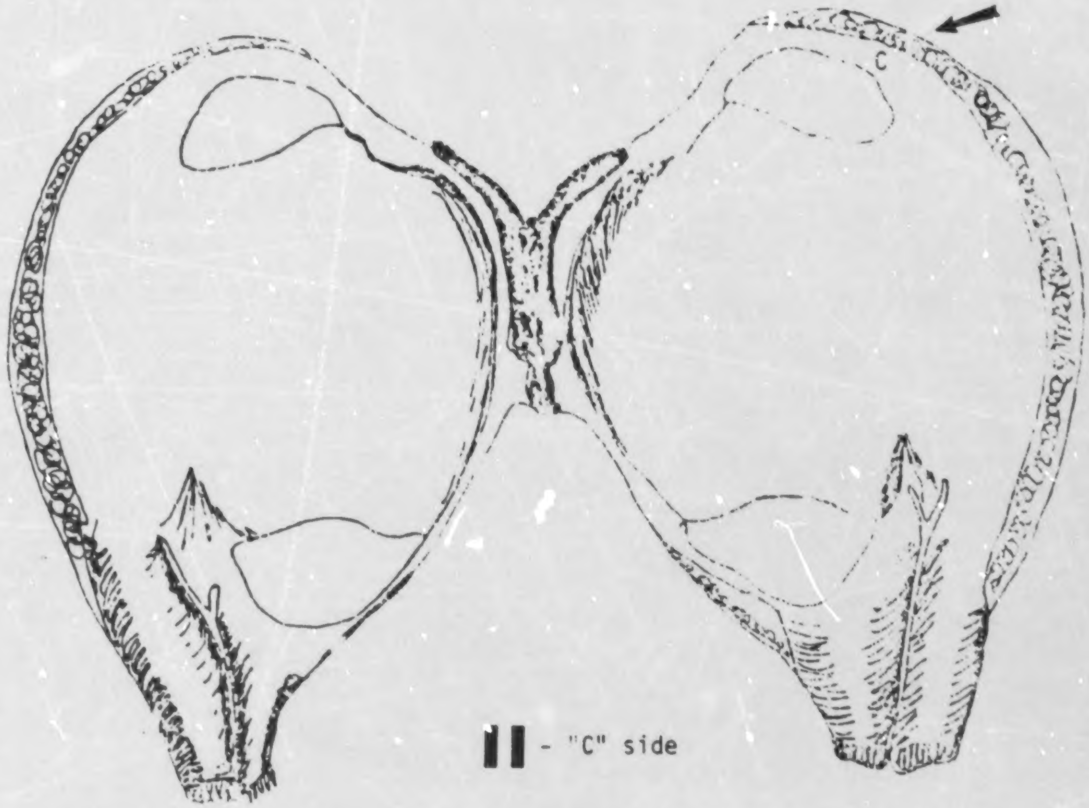
I - "A" side



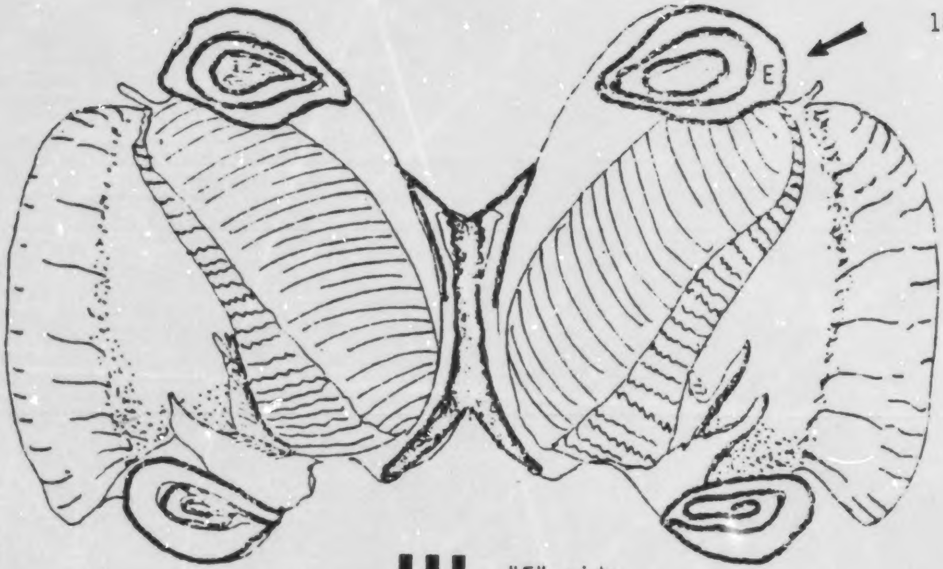
II - "D" side



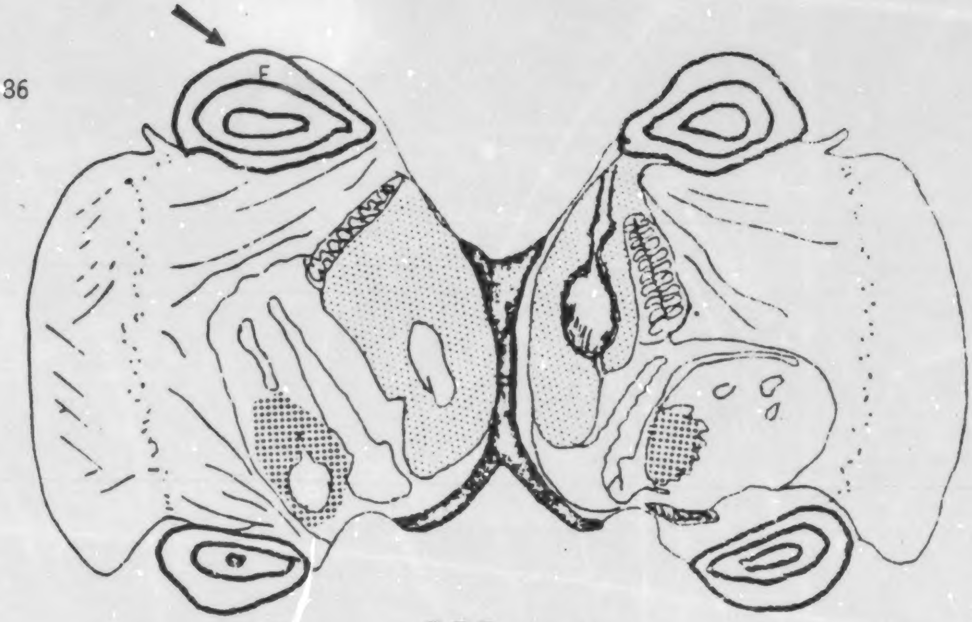
I - "B" side



II - "C" side



III - "E" side



▮▮▮ - "F" side

TEACHER BACKGROUND - Open Sesame

The purpose of this activity is to give your students an opportunity to see and feel a real clam. Clams may be obtained at the beach or at a fish market or supermarket near you. Clams in the shell are, of course, the preferred item. While it is possible for the teacher to do this activity as a demonstration (certainly better than not doing the activity at all), it is best if you can obtain enough clams to permit groups of about 4 students to perform the activity.

(Since drawings of the internal organs of an organism and the real organs sometimes seem to have little in common, it is recommended that the teacher perform this activity prior to use with the class.) Preview will greatly help your presentation.

If you dig your own clams, they may be cleaned by placing them, for about twenty-four hours, in a gallon of sea water to which 2 tablespoons of corn meal has been added. To open the clams, place them in boiling water until the muscles relax and the shell opens.

Duplicate the activity pages. One set is recommended per student.

KEY

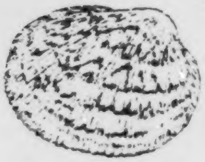
1. Two shells make up the case of the body.

2.-9. Answers will vary depending upon experimental observations.

10. Rapid digging can help a clam escape from predators.

KEY WORDS

- average
- bury
- circulatory system
- digestive system
- dorsal
- features
- gills
- heart
- intestines
- mantle
- muscle
- nervous system
- obtain
- oxygen
- plankton
- reproductive system
- respiratory system
- senses
- stomach
- survive
- ventral
- width



OPEN SESAME

Clams seem like simple animals. However, they have many special features that help them survive. "Open Sesame" will give you a chance to look at some of these features.

Materials needed for each group:

Clam	Pencil
Shallow tray	Ruler

The Outside

Obtain a clam and tray from you teacher.

1. How many shells make up the case for the body?______________________
2. What colors are the shells?______________________________________

   ____

Notice that shells are joined on the back (dorsal) side. They are open along the front (ventral) side. Measure the width (from front to back) of the clam.

3. How wide is your clam?______________________________________

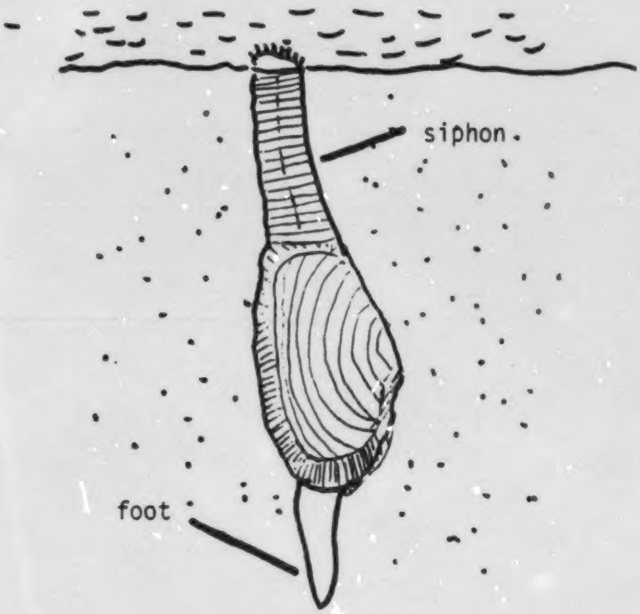
Measure the length (from one end to the other).

4. How long is your clam? ______________________________________

Write (record) the length on the blackboard. Your teacher will tell you where to write on the board. After all groups have recorded their measurements (length) answer the following questions.

5. How long is the longest clam?______________________________
6. How short is the shortest clam?____________________________
7. Estimate (make an educated guess) the average or middle size for the length of the clams. __________________________
8. Find the true average. Do the following:
   a) add all of the lengths
   b) divide the total by the number of clams measured. Your answer is the average.

Look at the Drawing of a Clam



Stand the clam up as if it is in the sand. Its neck or siphon should stick up. Its foot should point down.

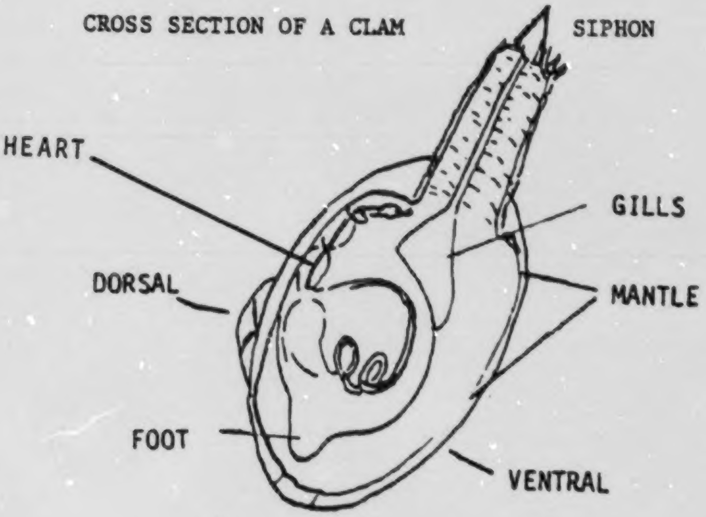
9. How many siphons (hollow tubes) are in the neck?________________________

One siphon pulls water into the clam. From this water the clam takes food and oxygen. Clams eat very small plants and animals that drift freely in the water. These drifting plants and animals are called plankton. The other siphon shoots out the used water and wastes.

The Inside

Open the clam by placing it in boiling water for about five minutes. The muscle will relax. Then the shells will separate. The body contains a foot. The clam uses the foot for digging. The body has a respiratory system with gills. The gills are for breathing. A digestive system with stomach and intestines is also in the body. These are used for food processing. The circulatory system has a heart to distribute food and oxygen.

The body's nervous system senses the surroundings. Its reproductive system produce new clams. Use the drawing below. Find the structures underlined above.



List the structures you can find in your clam that are shown in the drawing.

a.
b.
c.
d.
e.
f.

Some clams can bury themselves in 12 inches of sand in 10 seconds.

8. How could this behavior help the clam survive?____________________

The clam likes to bury itself so its siphon is on the surface. This way the siphon can get the food and water it needs. The clam can still stay hidden in the mud or sand. By digging with its foot the clam hides from enemies such as snails, crabs, starfish and fish.

Return the clam to your teacher
Clean up the area in which you worked and return the equipment you used.

TEACHER BACKGROUND - Open Sesame Puzzlegram

The Open Sesame Puzzlegram is a device used to build vocabulary skills. The definitions come from the text section of the "Open Sesame" activity.

Students may work on this item as individuals or in small groups depending upon your preference and the reading abilities of your class.

KEY - puzzlegram

1. Gills
2. hEart
3. siphOn
4. Dorsal
5. gUess
6. stomaCh
7. planKton

OPEN SESAME PUZZLEGRAM

Fill the correct word in the blanks using the clues given below. The correct answer will have the same number of letters as blanks in the Puzzlegram. When you have answered all of the clues and filled in the blanks of the Puzzlegram, a word dealing with clams will appear.

1. (__) __ __ __ __
2. __ (__) __ __ __
3. __ __ __ __ (__) __
4. (__) __ __ __ __ __
5. __ (__) __ __ __
6. __ __ __ __ __ (__) __
7. __ __ __ __ (__) __ __ __

CLUES

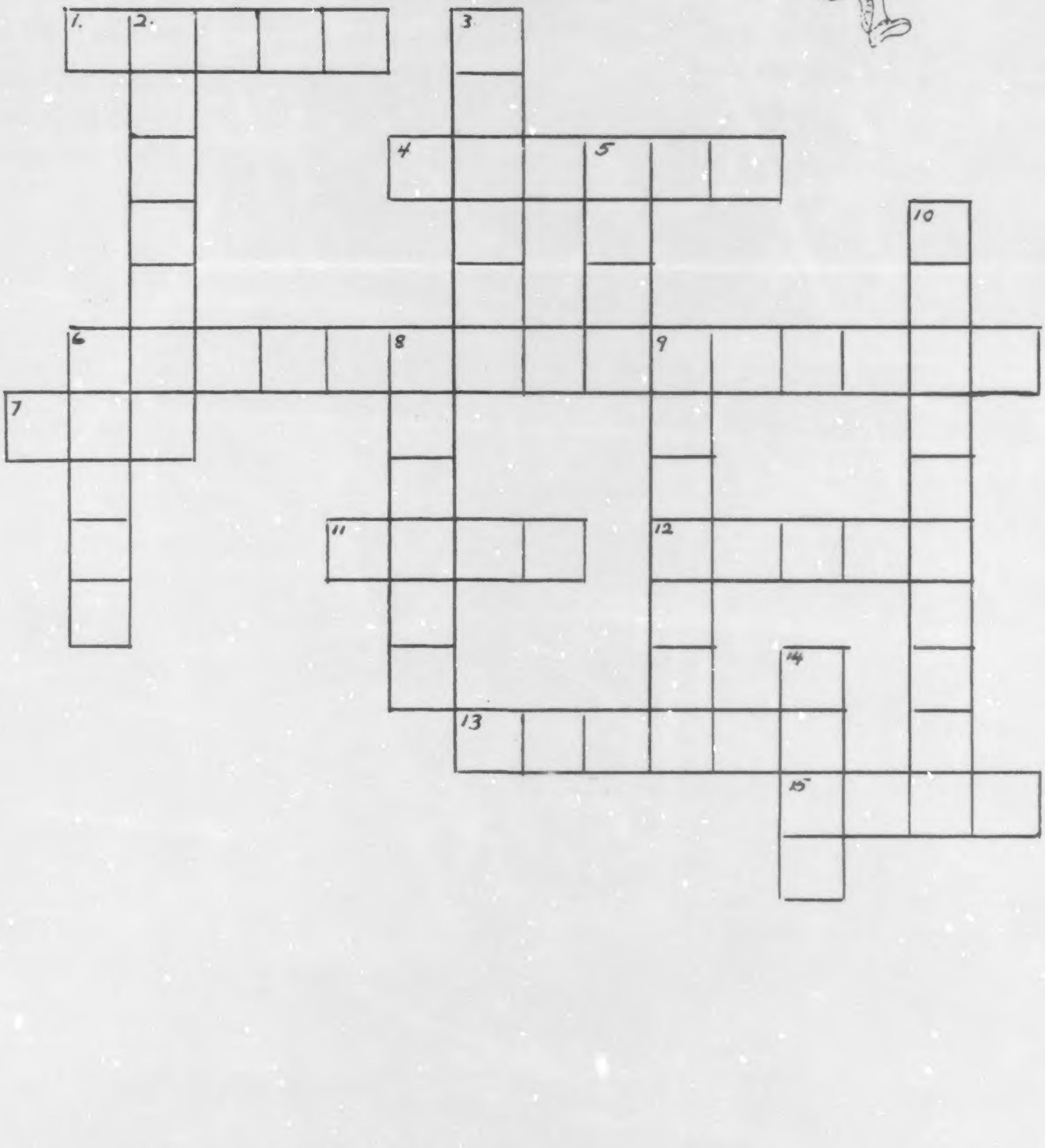
1. These are used for breathing.
2. This pumps food and oxygen
3. Found in the neck, this hollow tube carries water.
4. The back or ________________side
5. An estimate is an educated________________________________.
6. Part of the digestive system.
7. Very small plants and animals that drift freely in the water.

TEACHER BACKGROUND - Hot Cross Clams

This crossword puzzle is a vocabulary building activity. The words used are found in the text of the section and are, for the most part, key words. Again, this assignment may be completed by individual action or through small group consultation. Both approaches have their advantages.

	1 S	2 H	E	L	L		3 M								
		A					A								
		B				4 D	R	E	5 D	G	E				
		I					K		O					10 C	
		T					E		W					O	
	6 H	A	R	V	E	8 S	T	I	N	9 G	C	L	A	M	S
7 D	O	T				H				E				M	
	R					E				O				E	
	S				11 C	L	A	M		12 D	I	V	E	R	
	E					L				U				C	
						S				C		14 N		I	
							13 C	O	C	K	L	E		A	
												15 C	A	L	M
												K			

HOT CROSS CLAMS CROSSWORD


1.
2.
3.
4
5
10
6
8
9
7
11
12
14
13
15

HOT CROSS CLAMS

Cross Crossword Puzzle

Across:

1. The hard outer covering of a clam.
4. This washes clams from the bottom with strong jets of water.
6. The title of this study is _________ ___________ (two words)
7. A small round spot.
11. People often eat the Little Neck _________ whole.
12. Geoducks are harvested by this person who wears a wet suit.
13. This shellfish is ground up for chowder.
15. People like to go claming when the water is ________ and not rough.

Down:

2. The place where the clam lives.
3. Many clams after they are harvested are taken directly to a ___________.
5. The opposite of up is ___________.
6. The second largest clam is the ___________ clam.
8. Clams have two hard _____________.
9. These very large clams are harvested by divers.
10. Harvesting the clams is only the beginning for the __________ clam digger.
14. Clams can be grasped by their ____________and then dug out.

HINT! Many of the words that answer the clues above are underlined in the story of clams.

Teacher background - creative writing

Creative writing is designed to fulfill three educational purposes:

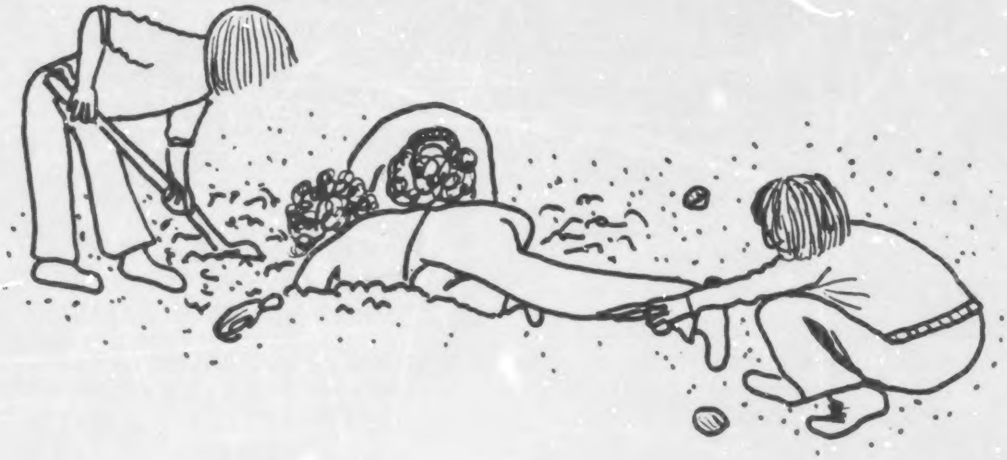
1. It contributes to the child's development of his powers of awareness, observation and sensitivity.
2. It contributes to the child's ability to communicate in an interesting and effective manner.
3. It develops the child's skill in using a creative approach to a task. This skill is fundamental to modern society and of particular value in a democratic society where every citizen must make decisions.

Allow the students ample time to complete the writing assignment. Help them with vocabulary etc. about which they ask but avoid suggesting topics as much as possible.

Open Sesame - Creative Writing

What's happening here?

Use your imagination. Look at the picture below and write a story describing what is going on here. Don't forget a title for your story.



SUGGESTED ADDITIONAL ACTIVITIES

1. Draw a clam. Label the siphon, foot, ventral side and dorsal side.
2. Draw the following clam shells as they look closed. Be sure to make them their actual size and include their rings.

little neck	cockle
butter clam	razor clam

3. Clean a geoduck clam.
4. Visit the Sea and Shore Museum in Port Gamble, Washington, Box 33, Port Gamble, Washington 98364, or call (206) 297-2426. Admission is free. (Call in advance for class tour.)
5. Take a field trip to the beach at low tide and dig for clams.
6. Make a model of a drawing of a clam dredge.
7. Invent another way clams might be harvested.
8. Visit a geoduck harvesting boat and examine their equipment.
9. Visit a local seafood market.
10. Visit a cannery at your nearest seaport.
11. Find information about clams in your library and make a report.
12. Arrange an interview with a local clam digger.

HARVESTING OYSTERS

TEACHER BACKGROUND - Harvesting Oysters

Please preview the text and activities before beginning this section. Prepare and duplicate the materials needed for "Guess Who's Coming for Dinner".

Tides are confusing for students. Be sure to read the Teacher Background section and understand it before doing "Oyster Tides". Familiarize yourself with the references listed if you have trouble with the concepts.

A clump of oyster shells can make a good starting point for discussion of this section. Supplement the text with pictures of oysters and oyster harvesting whenever possible.

Duplicate the text and the activity pages. One set is recommended per student.

KEY

1. The Pacific oyster is from Japan.
2. Oyster babies are called spat or plankton.
3. Three ways to harvest oysters are:
    a. dredge
    b. hand
    c. raft
4. Shuckers remove the oyster meat from the shells.
5. A few of your students will have eaten oysters in some form.

KEY WORDS - Oysters

ancestors

aquaculture

barge

conveyor belt

cultch

cycle

dikes

dredged

native

oyster

oyster beds

pollution

processing plant

scatters

seed

shuckers

spat

survive

HARVESTING OYSTERS

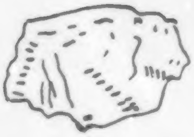
Before they began to fish and hunt, our ancestors gathered oysters for food. For several thousand years the oyster has been "farmed". The oyster is still used to study techniques for farming the sea (mariculture or aquaculture).

HISTORY

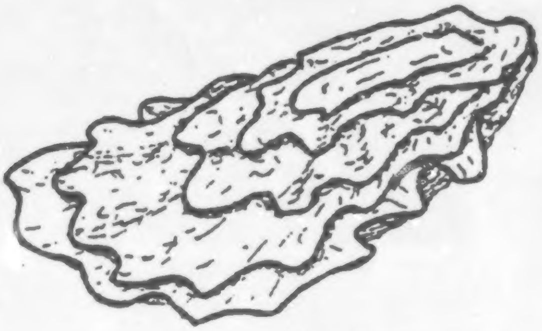
Pacific Northwest Indians used oysters as well as clams. They were a regular part of their diet. By the 1860's, oysters were being dredged (pulled off the bottom) in large numbers. The native oyster soon nearly disappeared. It was not able to withstand the harvesting and pollution. Today only a few native oysters survive in Southern Puget Sound and in Yaquina Bay, Oregon.

In the early 1900's a search began. Man wanted an oyster that could withstand the changes in the waters. The oyster also had to grow rapidly. One of the oysters tried was the Pacific oyster from Japan. By the 1920's Pacific oysters were being raised commercially in Puget Sound. The Pacific oyster has done very well. Oyster farmers on the west coast grow nearly 10 million pounds a year.

1. The Pacific oyster is from ______________________________.



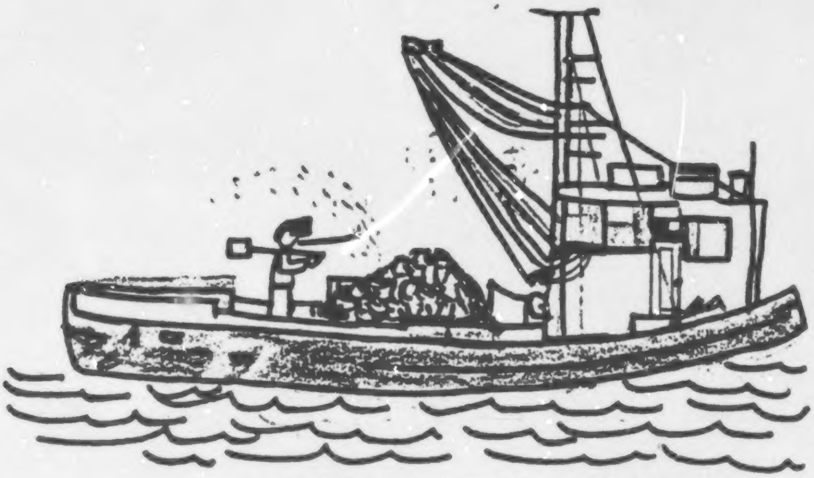
NATIVE OYSTER



PACIFIC OYSTER

How Oysters Are Grown

Oysters grow well with tender loving care. Most baby oysters are still imported from Japan. These babies are called "spat". At first, they are free-swimming plankton. In Japan the free-swimming oyster babies are caught on "mother-shell strings" (cultch). They remain there for the rest of their lives. The seed is shipped in the spring. There are about 18,000 oysters per case. The seed is planted in early April. To plant the seed, the oysterman hand scatters the seed-covered mother-shells from a dredge. Several years pass before the oysters are ready for harvesting.



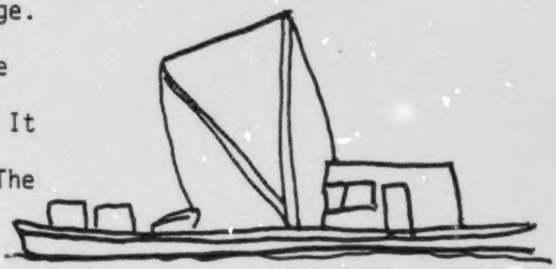
Scattering Mother-Shells

2. Oyster babies are called ________________________ or ________________________.

Harvesting Oysters

Oysters are harvested when they are two to four years old. At this time they are about two to four inches long.

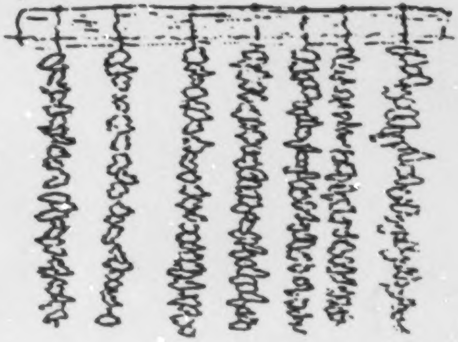
There are many ways to harvest oysters. The most popular method used in Puget Sound is by dredge. Oysters live in areas called oyster beds. The dredge picks up the oysters from these beds. It drags a heavy wire basket along the bottom. The basket is lifted to the surface. The oysters drop onto a barge. It is later towed to a processing plant. There the oysters are made ready for market.



OYSTER DREDGE

Sometimes the oysters are picked directly from the oyster beds by hand. This is done at low tide. Oyster pickers put the oysters into baskets or load them directly onto a barge. Picking stops when the tide comes in. The baskets and/or barge are then towed to the processing plant.

Another method of harvesting oysters involves floating rafts. Spat covered shells are strung on wire. The wires are hung from the floating rafts. The oysters are left until they reach the proper size. The strings are then taken from the raft. Some harvesting of oysters is done within dikes. These dikes are man-made walls. They are used to keep sea water in shallow bays. Again, the oysters are left until they reach the proper size. They are then harvested and made ready for market.



3. Three ways to harvest oysters are:

a. ______________________________

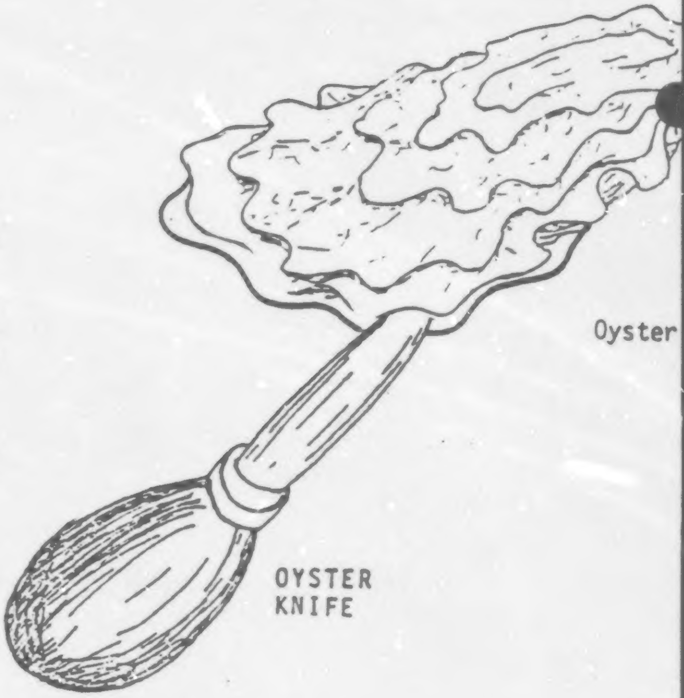
____

b. ______________________________

c. ______________________________

Marketing Oysters

When the oysters arrive at the processing plant they are sorted. The meat is removed from shells by people called "shuckers." To shuck an oyster it is placed on a wooden block. The shell is opened with an oyster knife. Hitting the edge of the oyster shell with a hammer can also open it. A good shucker can pick about 25 gallons of oyster meat per day.



4. What does a shucker do? ______________________________

____

The shucked oysters are washed and inspected for damage. They are then sorted to size. Some oysters are packed in jars or cans and labeled for the fresh market. Others are frozen for use at a later date.

The empty shells many times are strung on wire. These shells start the cycle again. They catch new oyster seed. Sometimes the shells are used in making roads. They can also be ground and used in animal feed.

Sometimes oysters are delivered to seafood markets or restaurants in their shells. They are packed in ice to keep them fresh during shipment. Commercial harvesting of oysters is the second largest commercial fisheries industry in the United States.

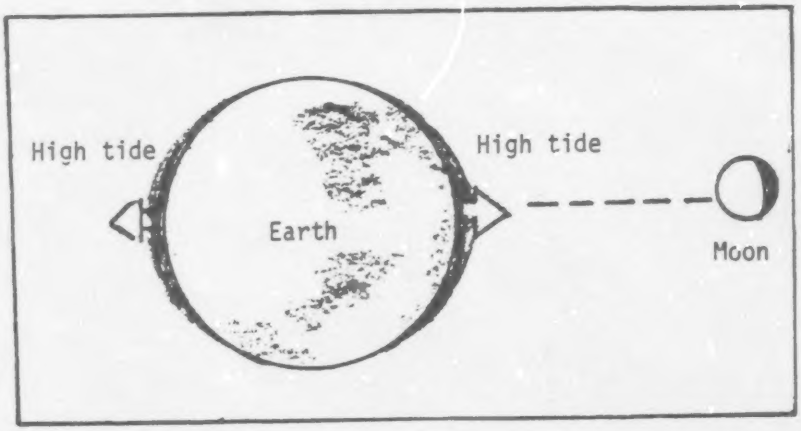
5. Have you ever eaten oysters? ______________________________

____

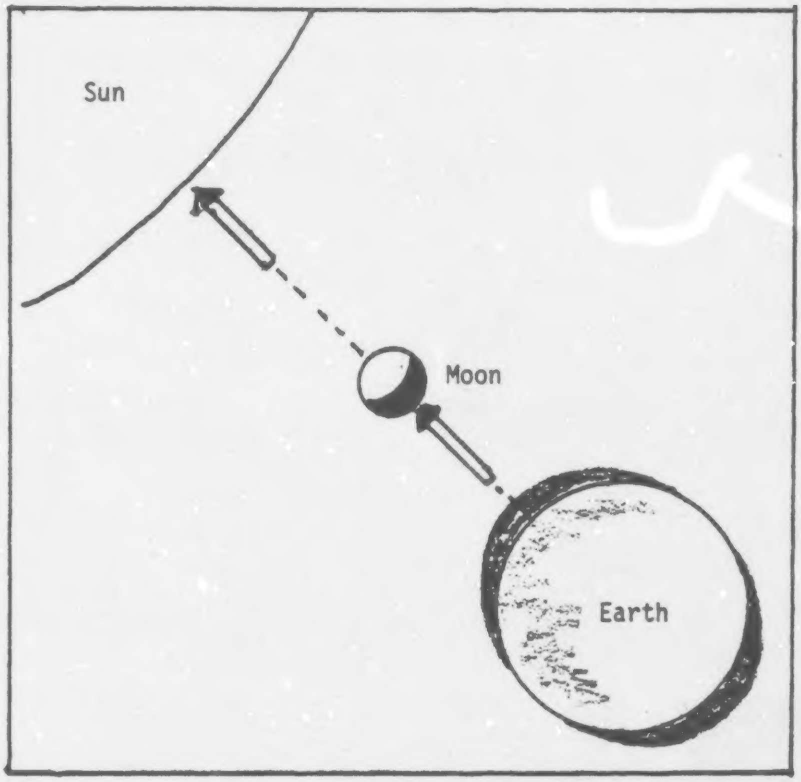
TEACHER BACKGROUND - Oyster Tides

Tides are an intergral part of knowledge of the sea. Yet, tides are often a difficult concept to grasp. The exercise "Oyster Tides" is designed as an introduction to the idea of tidal movement and tidal differences any good oceanography text can supply you with material to understand the causes of the tides. If you desire to involve the class at a deeper level you might read them The Rise and Fall of the Sea by Ruth Brindze (1964. Harcourt, Brace and Word, Inc. New York. 96 pages).

The tides we see are a result of gravity. The moon and the sun exert attractions on the waters of the earth. Eventhough the moon is much smaller, the moon, because it is so close to the earth, exerts the major pulling force on the water causing a great bulge in the ocean directly under it. This tidal bulge tends to follow the moon as it orbits around the earth. The centrifugal force from the earth's rotation creates a second bulge in the ocean on the opposite side of the world.

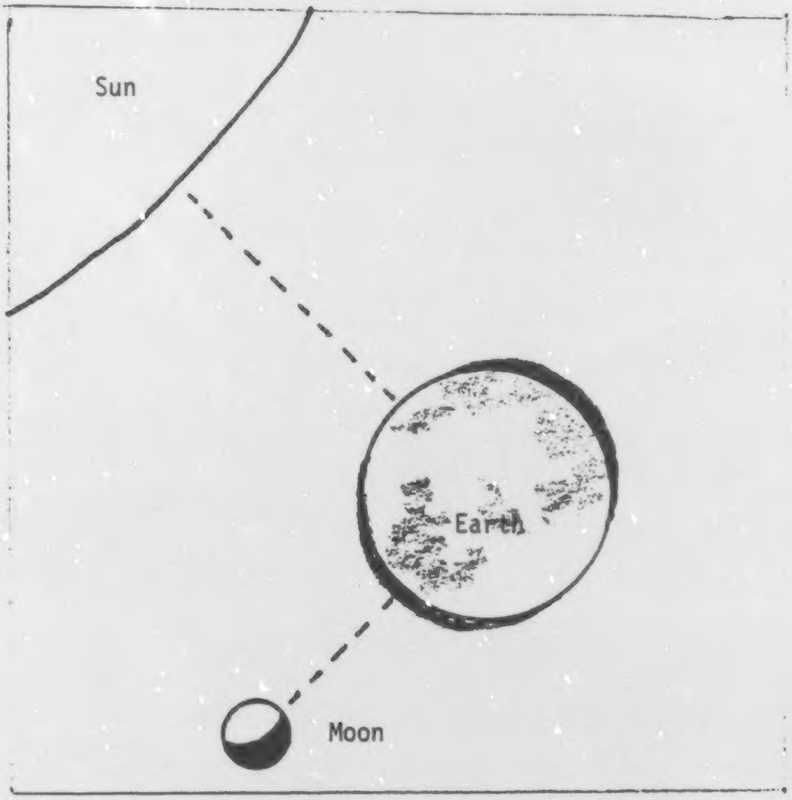


The effect of the sun is to increase or decrease the size of the bulge created by the moon. Once every 28 days the sun and the moon are in line with each other. At this time, the combined pulling forces of both the sun and the moon on the earth produce the highest rise in water levels along our coasts. These tides are called spring tides. Spring tides occur all year long. The term "spring" comes not from the season but rather from the "springiness" of the water movement.



SPRING TIDES

Twice every 28 days the moon is at right angles to the sun. The attraction of the moon for the earth cancels out the sun's attraction for the earth. At these times, there is the smallest rise in water levels. We call these tides "neap tides."



NEAP TIDES

Tidal rises and falls occur twice each twenty four hours and fifty minutes. The height and times of the tides are also influenced by the shape and location of the shoreline.

For further information you may want to see "Understanding the Tides" an Oregon State University Sea Grant publication SG 25 by R. Lawrence Swanson. The publication is available free from Oregon State University Extension, Corvallis, Oregon 97331.

The idea of a 24 hour clock is strange to some students. Provide additional examples, if necessary. You might consider the concept of computing time differences using the 24 hour clock. Keep in mind that the first two digits of a time expression represent hours, and that the last two digits refer to minutes. Minutes amounting to 60 or more must be converted to hours (in addition, for example). If subtracting minutes and "borrowing" becomes necessary, remember that when you "borrow" from the second digit you are borrowing sixty minutes. Similarly you can go back into the next day and "borrow" 24 hours.

Recall that the times and heights of tides vary with time. The exercises do not have a year listed but it is wise to mention to students that not every May 31, for example, has the same tides. Also emphasize that tides differ from location to location on the planet.

The last portion of the exercise may be omitted or assigned as homework.

KEY

AM - PM CLOCK	24 HOUR CLOCK
1. 7:52 AM	0752 hours
2. 7:52 PM	1952 hours
3. 10:00 AM	1000 hours
4. 10:00 PM	2200 hours
5. 3:30 PM	1530 hours
6. 5:15 PM	1715 hours
7. 12:00 Noon	1200 hours
8. 12:00 Midnight	2400 hours or 000 hours
9. 12:04 AM	0004 hours

Have you mastered the 24 hour clock? Let's take a look at the tides for May 31. Use the tide on the next page. Find out when the high and low tides occurred on the AM - PM clock.

TIDE	24 HOUR CLOCK	AM - PM CLOCK
First high tide	0208 hours	2:08 AM
First low tide	0909 hours	9:09 AM
Second high tide	1532 hours	3:32 PM
Second low tide	2103 hours	9:03 PM

Which tide time would be best for gathering oyster? First low tide

Below are the tides for August 29 at Seattle, Washington.

TIDE	24 HOUR CLOCK	AM - PM CLOCK	HEIGHT OF TIDE
First low tide	0114 hours	1:14 AM	0.5 feet
First high tide	0731 hours	7:31 AM	10.4 feet
Second low tide	1315 hours	1:15 PM	3.1 feet
Second high tide	1921 hours	7:21 PM	11.8 feet

Change the 24 hour clock times to AM - PM clock times.

At what time does the highest tide occur? 1921 or 7:21 PM

Which tide would be best for gathering oysters? First low tide

At what time does the best oyster gathering tide occur? 0114 or 1:14 AM

For August 29, what is the range of tides? (The range of tides is the difference (subtract) between the highest high tide and the lowest low tide.)

11.3 foot range (ie. 11.8 feet - 0.5 feet)

Which of the four tides above for August 29 would you choose for gathering oysters? Probably second low Why? because of the time of first low.

Answers may vary. Answers will vary for tides found in local newspapers.

KEY WORDS -

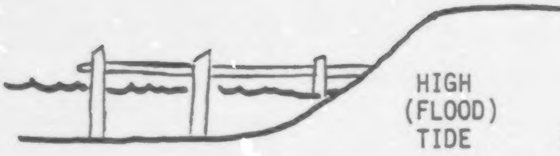
A.M.
digits
ebb tide
flood tide
harvest oysters
height
location
midnight
minus tide
motion
plus tide
positions
P.M.
tide table

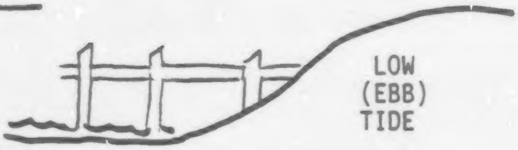
OYSTER TIDES

The ocean is full of motion. The tides are the moves the ocean makes, to and fro. If you live near the ocean, you may have seen the motion. Sometimes rocks and parts of the beach are covered with water. Other times these same areas are not covered. What you are seeing are the tides.

When the water level is high, more of the beach is covered with water. The beach may appear to be a very small or narrow beach. This is called high or flood tide.

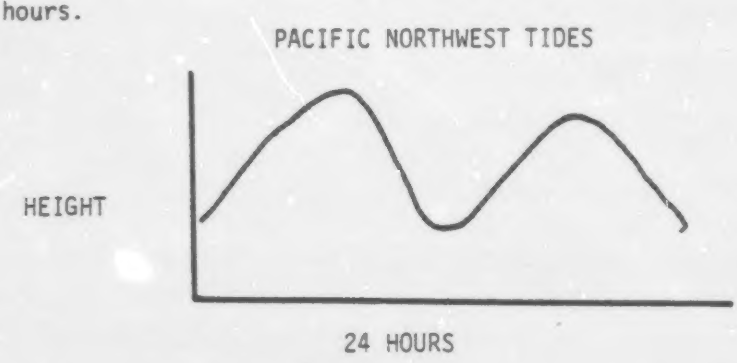
When the water level is low, less of the beach is covered with water. The beach appears to be larger or wider. This is called a low or ebb tide.





The difference between the ebb tides and the flood tides may be only a few inches. However, it maybe as much as 40 feet.

The effect of the sun and the moon on the earth help cause the tides. In the Pacific Northwest, we have two high tides and two low tides about every 24 hours.



People who harvest oysters need to know when the high and low tides occur. Otherwise they may have trouble doing their work. When would be best time for you to harvest oysters from the beach?

Hand harvesters look for the low tides to harvest oysters. They look up the times in a tide table. Tide table times are often written using the 24 hour clock. With the 24 hour clock we do not use the terms AM and PM. The day begins at midnight and runs for 24 hours.

When we use the 24 hour clock, time is expressed in "hundreds". For instance, 8:00 AM would be read "eight hundred hours". 2:30 PM would be read "fourteen-thirty hours". To change PM times to the 24 hour clock we simply ADD 12 hours.

Try your skill at changing the following times to the 24 hour ocean scientist's clock:

AM - PM CLOCK	24 HOUR CLOCK
1. 7:52 AM	0752 hours
2. 7:52 PM	________
3. 10:00 AM	________
4. 10:00 PM	________
5. 3:30 PM	________
6. 5:15 PM	________
7. 12:00 Noon	________
8. 12:00 Midnight	________
9. 12:04 AM	________

Have you mastered the 24 hour clock? Let's take a look at the tides for May 31. Use the tide below. Find out when the high and low tides occurred on the AM - PM clock.

	24 HOUR CLOCK	AM - PM CLOCK
First high tide	0208 hours	________
First low tide	0909 hours	________
Second high tide	1532 hours	________
Second low tide	2103 hours	________

Which tide time would be best for gathering oysters? ________

Tides are caused by differences in the positions of the sun and moon and earth. The distance the tide rises and falls changes from day to day. The distance also changes from location to location on the earth.

Daily tides are compared to past tides. Tides are sometimes higher than the average of past tides (plus tides). Tides are sometimes lower than this average (minus tides). Minus tides are written with a minus sign (-) before the number. The number gives the tidal change in feet.

Below are the tides for August 29 at Seattle, Washington.

TIDE	24 HOUR CLOCK	AM - PM CLOCK	HEIGHT OF TIDE
First Low Tide	0114	____________	0.5 Feet
First High Tide	0731	____________	10.4 Feet
Second Low Tide	1315	____________	3.1 Feet
Second High Tide	1921	____________	11.8 Feet

Change the 24 hour clock times to AM - PM clock times.

At what time does the highest tide occur? ____________________

Which tide would be best for gathering oysters? ____________________

At what time does the best oyster gathering tide occur? ____________

For August 29, what is the range of tides? (The range of tides is the difference (subtract) between the highest high tide and the lowest low tide.)? ______________________________

Which of the four tides above for August 29, would you choose for gathering oysters? ______________ Why? ____________________

____

If you live near the ocean, look at the tide table in the paper tonight. Find the times and heights of tomorrow's tides. Fill in the blanks below with the necessary information.

TIDE	TIME (24 hour)	TIME (AM-PM)	HEIGHT OF TIDES

When is the lowest low tide?______________________________

When is the highest high tide?______________________________

Next time you go to the beach, be sure to find out when the high and low tides will occur HAVE FUN!

TEACHER BACKGROUND - Folding Oysters

"Folding Oysters" gives your students an opportunity to put together an oyster finger puppet while learning something about oyster anatomy and physiology. This is a fun activity and will reinforce many of the concepts introduced in preceding activities on oysters and clams.

The activity provides some information about the structures found inside the living oyster and about how those structures function. In addition to the items mentioned, consider pointing out the growth lines on the shell, the places for the attachment of the muscle which closes and opens the valves, and the mantle which is the soft part of the shell which secretes the hard shell. A good source for additional information about oyster anatomy is:

Barnes, Robert D. 1980. Invertebrate Zoology.
W.B. Saunders Company.

Duplicate the activity pages. One set is recommended per student. It is important that your students follow the directions in the procedure section in the order given and that they answer the questions as they procede. Provide time for a discussion of the activity and the questions as a follow-up. Consider displaying your students' oysters by punching a hole in one of the shells and hanging them by a string through the hole.

KEY .
Text:
1. Tiny, free floating animals like oyster spat are called plankton. Technically, animal plankton is called zooplankton and plant plankton is called phytoplankton.

2. Oysters eat plankton, both tiny animals and tiny plants.

3. This question is designed to make your students think of the range of possibilities. The obvious answer is by hand. Other creative answers might include SCUBA diving, vaccuum cleaners, nets, and fishing hooks.

Procedure:

2. a. Drawing D shows the internal organs.
   d. The oyster holds its valves together to avoid being eaten and to avoid drying out when the tide goes out.
   e. Oysters, again, eat plankton, both tiny animals and tiny plants.

KEY WORDS

adductor muscles
bivalved
carbon dioxide
commercial
cultch
diagrammed
dredges
filter
gills
intertidal zone
organs
oxygen
plankton
record
shucked
spat
tongs

FOLDING OYSTERS

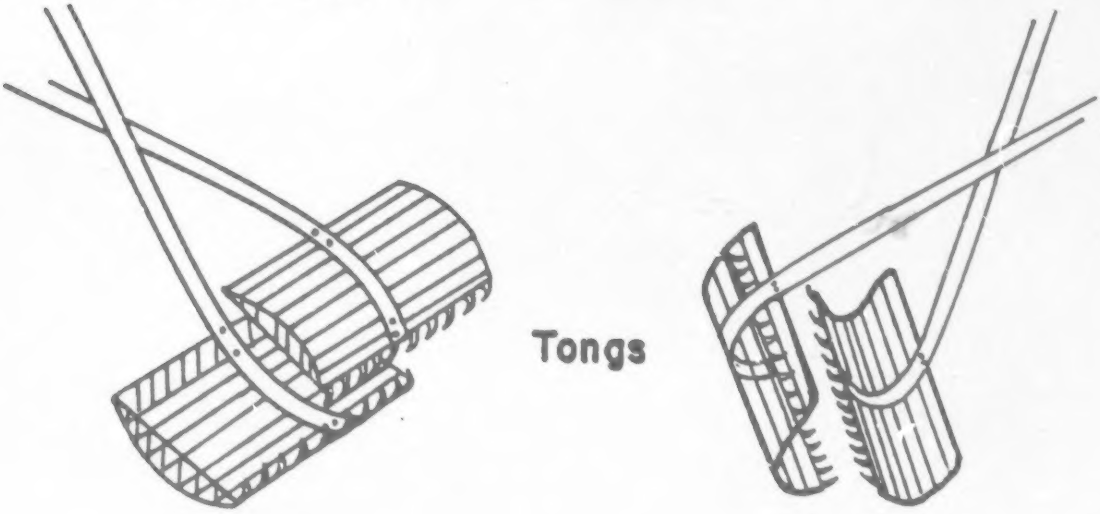
Over a hundred different two-shelled (bivalved) animals wear the name "Oyster". Oysters live in the intertidal zone. These are the shallow waters along the coasts. Oysters start their lives as tiny, free floating plankton. Planktonic oysters are called spat. As they float, they eat and grow.

1. What do we call tiny, free floating animals like oyster spat?

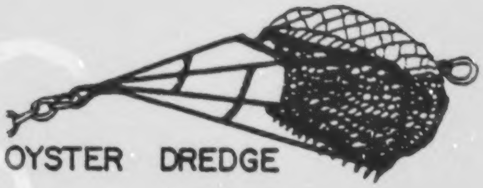
Soon, they attach themselves to rocks or other oysters. Commercial oyster growers string shells together. The shells provide homes for oysters. These shell strings are called cultch. Once located, oysters never move again. Oysters feed on plankton, both tiny animals and tiny plants. They filter the plankton from the water. They move the water through their bodies.

2. What do oysters eat?

Oyster harvesters may use tongs or dredges. Tongs open and close somewhat like scissors.



Dredges are dragged along the bottom from boats. The oysters are scooped up by the dredge.


OYSTER DREDGE

3. How else might you gather oysters?

Oysters are separated by size and quality. After grading, they are packaged. Many are sold live in the shell. Others are sold shucked (out of the shell), frozen and canned. They are prepared in a variety of ways.

Have you ever eaten an oyster? We eat the soft part within the shell. Next time you eat an oyster look carefully. The inside of an oyster is made up of several parts. Now, you can learn about the oyster's insides.

MATERIALS - Here's what you'll need....

oyster sheet
scissors
paste or glue
crayons or colored felt tips
sheet of paper

PROCEDURE - Here's what you do....

1. Obtain an oyster sheet. Look carefully at the four oyster drawings. With a pencil, circle the letters from A to D.

2. Drawings A and B show the outside of the oyster. Drawings C and D show two views of the oyster's insides.

a. Which drawing shows the internal organs?
(Hint: the heart would be an organ.)

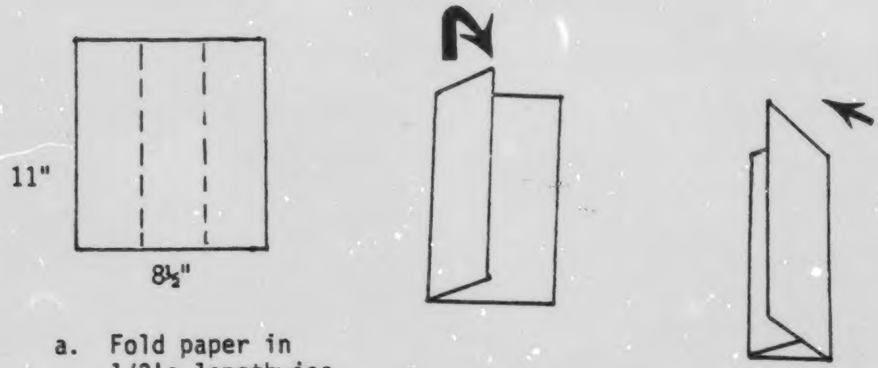
b. The adductor muscles are very strong. They hold the two valves (shells) of the oyster together. Why might the oyster want to hold its valves together?

c. On drawings C and D, color the adductor muscles.
Record the color you used in this space. ____________

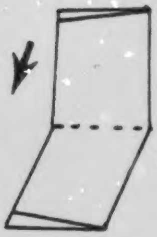
d. On drawing "C", color the gills. Record the color you used in this space. __________

e. The gills have three functions. They absorb oxygen and release carbon dioxide. They also catch food particles. Finally, they move the food to the oyster's mouth. What do oyster eat?

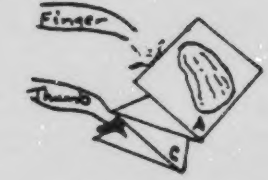
3. Obtain a plain sheet of paper. Follow the directions diagramed below to fold your paper.



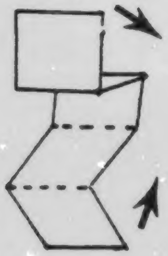
a. Fold paper in 1/3's lengthwise.



b. Fold paper in half.



d. Put your fingers in the pockets. Open and close your oyster.



c. Fold each half in half again away from fold.

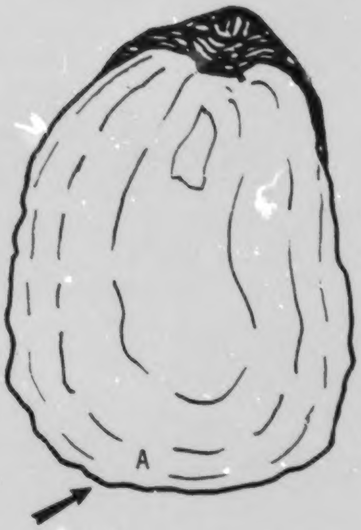
4. Put your fingers in the pockets in the folded paper. With a pencil start on the top surface. Write a small A on the topside of the top "shell". Write a B on the underside of the top. Write a C on the top side of the bottom "shell". Write a D on the underside of the bottom.

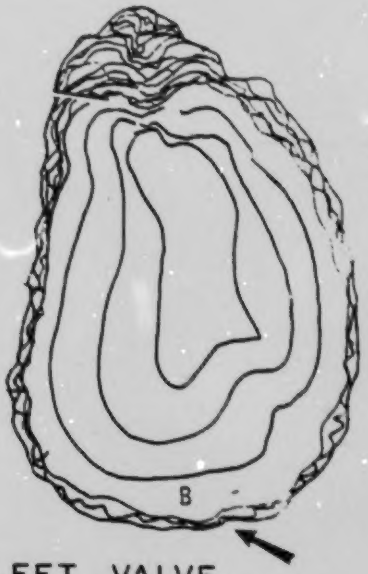
5. Cut out drawing A. On the folded sheet, find your pencil letter A. Glue drawing A to this surface. Next, cut out drawing B. Glue drawing B to the side with your pencil letter B. Continue on through letter D.

6. Put your fingers inside your two shells. Open and close your oyster.

RIGHT VALVE
(flat)

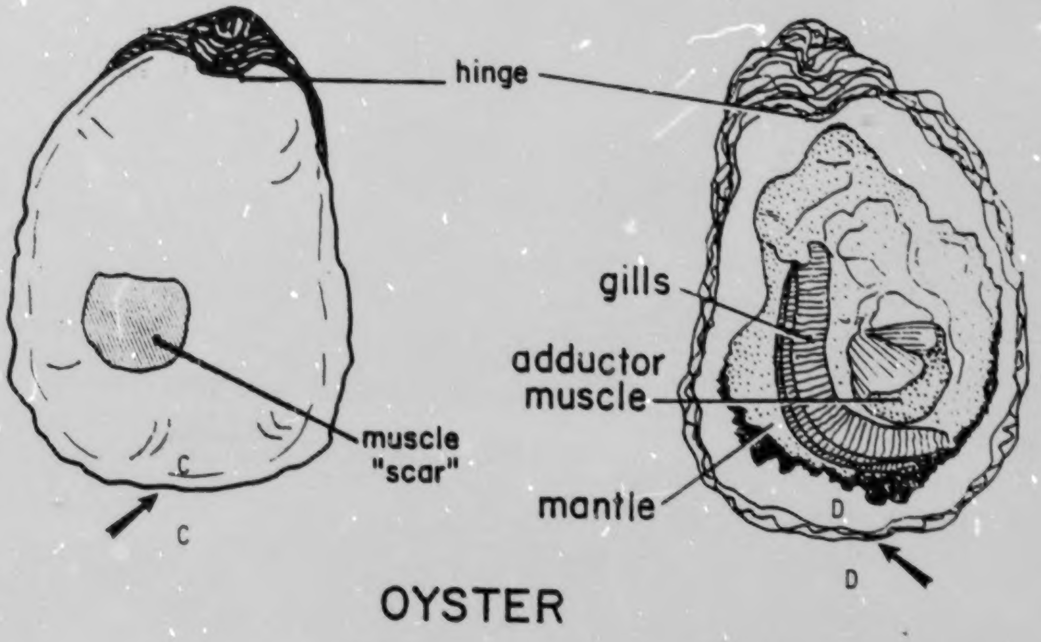
LEFT VALVE
(cupped)



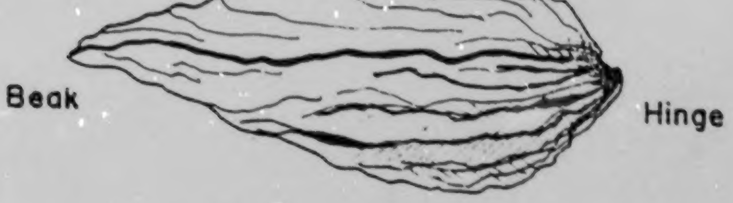


A - RIGHT VALVE
(flat)

B - LEFT VALVE
(cupped)


hinge
gills
adductor
muscle
mantle
muscle
"scar"
C
C
D
D

OYSTER



TEACHER BACKGROUND - That's Life

"That's Life" gives the student practice in a skill necessary for developing reading effectiveness. The student must arrange a group of related facts in the proper order. You may have the students work independently or in small groups on this assignment. You may also elect to let the students work independently then have them meet in small groups to discuss their order. At the conclusion of the discussion, you should plan to briefly discuss the correct order.

KEY - correct order

5 Oysters are shucked

2 Spat is imported from Japan

4 Oysters are harvested by dredge

8 Oysters are fried for dinner

1 Free swimming oyster spat is caught on "mother shell" strings

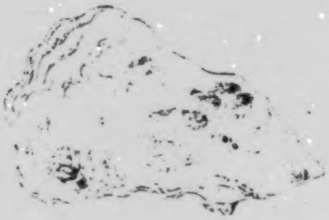
3 Oyster seed is scattered by hand

6 Oysters are placed in jars or cans

7 Oysters are delivered to the stores

KEY WORDS

aimlessly
dredge
delivered
fried
goal
harvested
imported
"mother shell" strings
scattered
shucked
spat



THAT'S LIFE

Ollie Oyster is having trouble. He is deciding what to do with his life. Below is a list of things that Ollie has to do before he can reach his goal. His goal is to get on your dinner table. Ollie is now swimming around aimlessly. Help Ollie to get to your table!

ARRANGE THE FOLLOWING EVENTS IN AN OYSTER'S LIFE IN THE CORRECT ORDER.

Write the number of the statement in the blank in front of the statement.

(For example, the first event in Ollie's life would be ____1____)

_________ Oysters are shucked

_________ Spat is imported from Japan

_________ Oysters are harvested by dredge

_________ Oysters are fried for dinner

_________ Free swimming oyster spat is caught on "mother shell" strings.

_________ Oyster seed is scattered by hand

_________ Oysters are placed in jars or cans

_________ Oysters are delivered to the stores

TEACHER BACKGROUND "GUESS WHO'S COMING FOR DINNER"

The following board game may be used as a review of the materials covered in this section on oysters. The game is best played with groups of two, but three may be used.

DIRECTIONS: Use the following originals to make duplication masters and duplicate the number of game boards and question sets needed for your class.
Cut the question cards on the black lines.
Provide each group with a game board and a set of cards plus one marker per person (buttons, checkers, shells, etc. will work).

Object of Game: The player to reach "Winner For Dinner" first, wins.

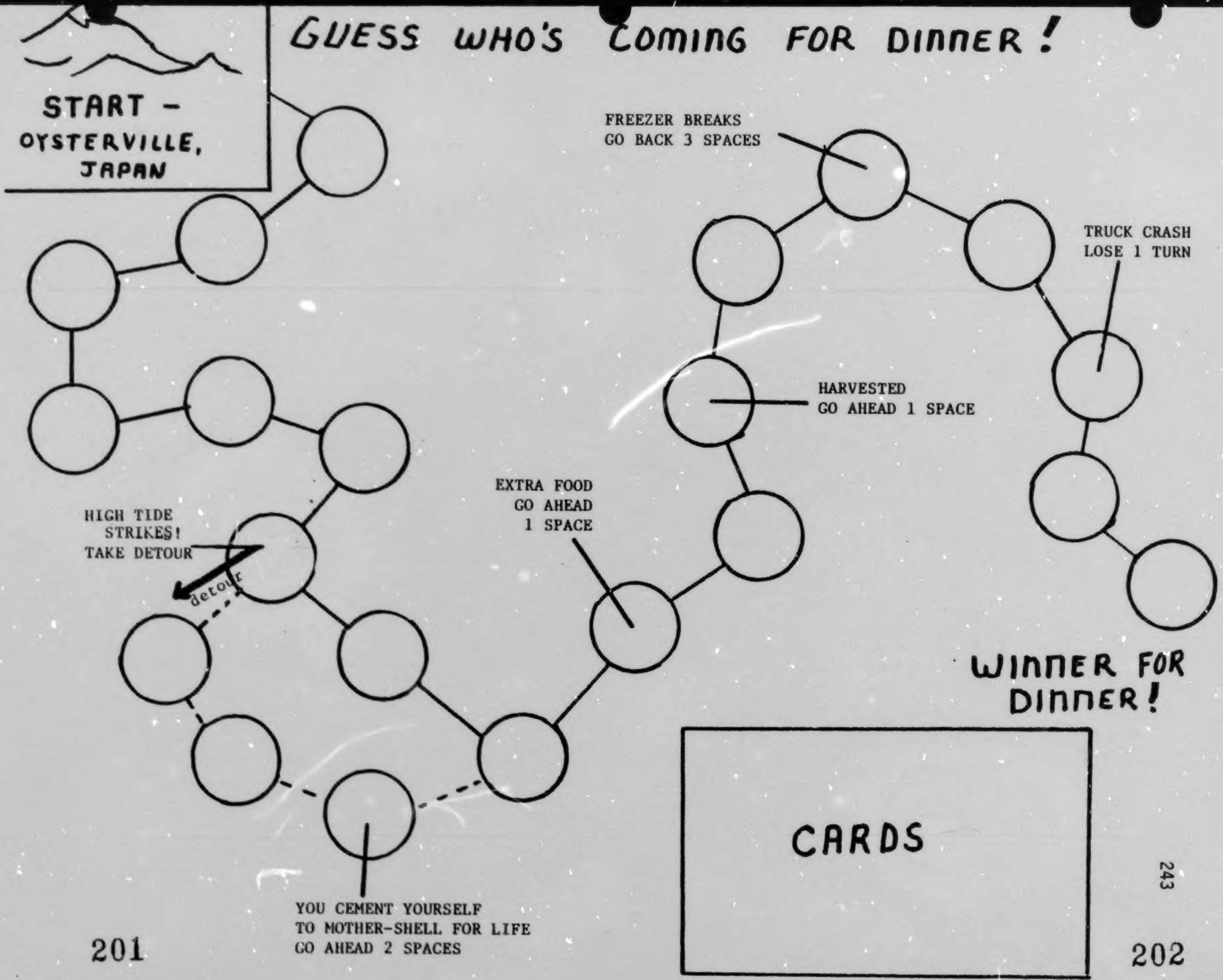
How to Move: All players start at Oysterville, Japan. The player to move

first is determined by the toss of a die. Highest number moves first.
Play moves to the left around the group.
The SECOND player to move takes the top card off of the card pile and reads the question aloud to the first player to move. The first player answers the question aloud to the second player. If his answer is correct (the correct answer is on the card), the first player gets to move his marker the number of spaces shown on the top of the card. If answer is incorrect, the player must leave his marker where it is.

The next player then selects the top card and reads it to the second player and so on until the game is terminated by a marker reaching the end.

If all cards are exhausted before a winner is determined, you may have the players shuffle the cards and begin again. Alternatively, you can supply additional questions.

GUESS WHO'S COMING FOR DINNER!


START -
OYSTERVILLE,
JAPAN
FREEZER BREAKS
GO BACK 3 SPACES
TRUCK CRASH
LOSE 1 TURN
HARVESTED
GO AHEAD 1 SPACE
EXTRA FOOD
GO AHEAD
1 SPACE
HIGH TIDE
STRIKES!
TAKE DETOUR
detour
YOU CEMENT YOURSELF
TO MOTHER-SHELL FOR LIFE
GO AHEAD 2 SPACES
WINNER FOR
DINNER!
CARDS

3 spaces for correct answer

Question: In the Pacific Northwest there are how many high tides about every 24 hours?

Answer: Two

---

3 spaces for correct answer

Question: In the Pacific Northwest there are how many low tides every 24 hours?

Answer: Two

---

4 spaces for correct answer

Question: What are two of the things that help cause the tides?

Answer: The sun and the moon.

---

3 spaces for correct answer

Question: Low tide is also called ___________?

Answer: Ebb tide

---

3 spaces for correct answer

Question: High tide is also called ______________?

Answer: Flood tide

---

3 spaces for correct answer

Question: What kind of a clock is used to tell times of tides?

Answer: The 24 hour clock

---

3 spaces for correct answer

Question: Use the 24 hour clock to give the following AM - PM clock time: 10:30 PM

Answer: 2230 hours (Twenty-two thirty hours)

---

3 spaces for correct answer

Question: Change the following 24 hour clock time to AM - PM clock time: 0152 hours

Answer: 1:52 AM

---

3 spaces for correct answer

Question: Use the 24 hour clock to give the following AM - PM clock time: 5:45 AM

Answer: 0545 hours (zero five forty-five hours)

---

3 spaces for correct answer

Question: Change the following 24 hour clock time to the AM - PM clock: 1530 hours

Answer: 3:30 PM

True - False: 2 spaces for correct

Question: Oyster farmers today raise the same type of oysters the Indians used for food.

Answer: False

True - False: 2 spaces for correct

Question: The oyster farmers raise oysters in prepared areas or plots called oyster trays.

Answer: False

True - False: 2 spaces for correct

Question: "Dredging" means putting oysters in small glass jars.

Answer: False

True - False: 2 spaces for correct

Question: Oysters are removed from their shells by people called "hucksters".

Answer: False

True - False: 2 spaces for correct

Question: Farmers today raise the Pacific oyster.

Answer: True

True - False: 2 spaces for correct

Question: Most oysters are sold in the shell.

Answer: False

True - False: 2 spaces for correct

Question: Free-swimming baby oysters are called seedlings.

Answer: False

True - False: 2 spaces for correct

Question: Commercial harvesting of oysters is the second largest commercial fisheries industry in the United States.

Answer: True

True - False: 2 spaces for correct

Question: Oysters are harvested when they are two to four years old.

Answer: True

True - False: 2 spaces for correct

Question: At ebb tide more of the beach is covered with water than at flood tide.

Answer: False

SUGGESTED ADDITIONAL ACTIVITIES

1. Look for oysters on a nearby beach.
2. Pick oysters for a meal. Help to shuck them. Be careful. Oyster knives are sharp!
3. Watch a commercial dredge in operation.
4. Tour an oyster processing plant.
5. Draw a picture of an oyster.
6. Visit an oyster hatchery.

COMMERCIAL SHRIMPING

TEACHER BACKGROUND - Commercial Shrimping

By this time, you are hopefully familiar with the mechanics of this unit. Again, please read the text and activities before beginning to teach about the section.

Brine shrimp eggs must be obtained prior to "How Hot Is Too Hot?". Three baby food jars per group are required for "How Hot Is Too Hot?". Ask members of the class with younger brothers and sisters to bring baby food jars as a special favor to you. A note home to parents is also helpful in obtaining the jars.

Duplicate the text and activity pages. One set is recommended per student.

Duplicate the data charts needed for "How Hot Is Too Hot?".

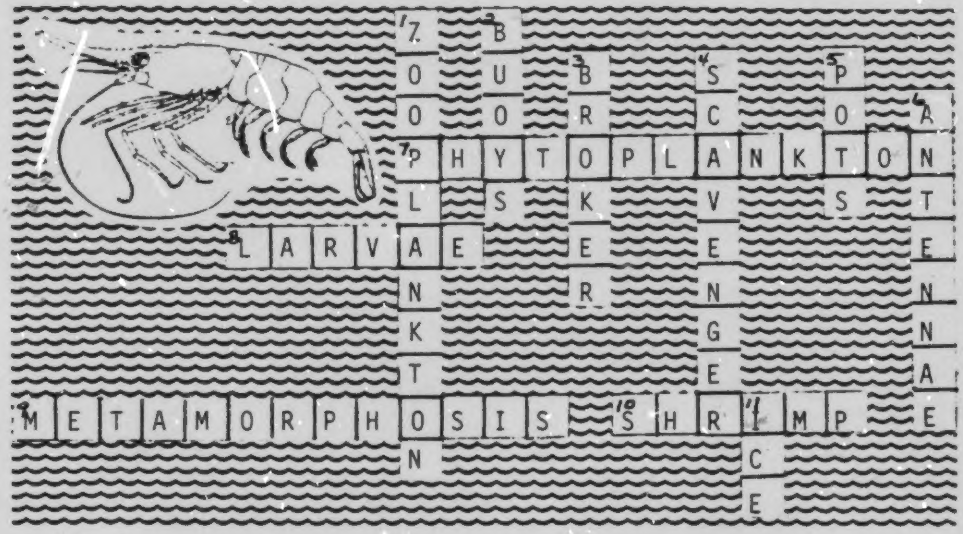
KEY

1. A scavenger is an animal that feeds on dead and rotting plants and animals.
2. Plankton are small (usually) freely drifting animals and plants.
3. a. The female shrimp carries her eggs for 4 to 5 months.
   b. Baby shrimp are called larvae for the first 30 to 35 days after they hatch.
   c. A female shrimp lays 3,000 eggs at a time.
   d. At 18 months the shrimp becomes mature male shrimp.
   e. At 2 years of age the shrimp become mature female shrimp.
4. The traps for shrimp are called shrimp pots.
5. Shrimpers mark the location of the shrimp pots with a buoy.
6. Shrimpers can market their crop directly or through a broker.
7. Many of your students will have eaten shrimp.

KEY WORDS - Commercial Shrimping

antenna e
buoy
coon striped shrimp
fish broker
larvae
metamorphosis
phytoplankton
plankton
scavengers
shrimp
shrimp pots
shrimper
spawn
winch
zooplankton

PUZZLING SHRIMP


1 ZOOPLANKTON
2 BUOYS
3 BROKER
4 SCAVENGE
5 POTS
6 ANTENNAE
7 PHYTOPLANKTON
8 LARVAE
9 METAMORPHOSIS
10 SHRIMP
11 ICE

Across

7. Small, drifting plant
8. The baby stage of shrimp
9. Changing form
10. A favorite sea food

Down

1. Small, drifting animals
2. Shrimpers mark pots with these
3. People who buy and sell shrimp
4. These feed on dead organisms
5. Some shrimpers use these
6. Long, whip-like sense organs
11. Shrimp are packed in this

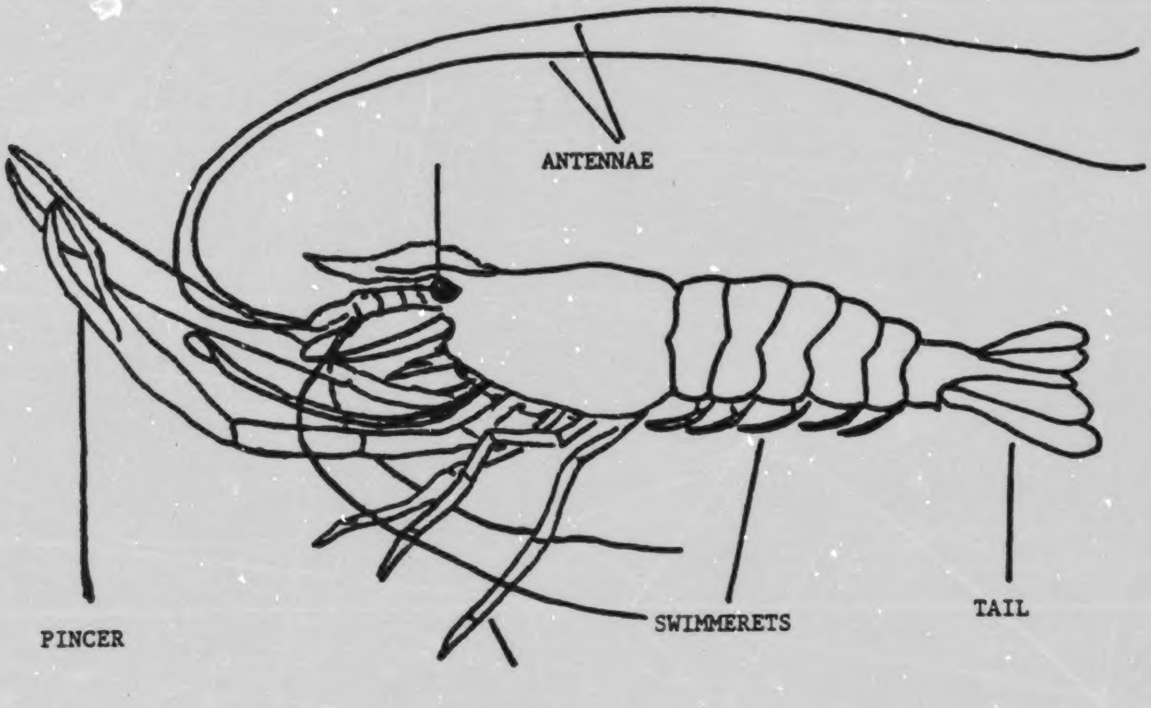
COMMERCIAL SHRIMPING

A favorite seafood of many people is shrimp. Shrimp can be found in several places around the world. They vary greatly in size. In the Puget Sound one shrimp is harvested commercially. It is the "spotted" or coon striped shrimp.

Have the only shrimp you have seen been in a salad? Then you are in for a surprise. Shrimp come in many colors and sizes. They have long, thin antennae and legs. Many shrimp move themselves backward by rapidly bending their tails. Shrimp are scavengers, they feed on dead and rotting plants and animals.

1. What is a scavenger? ______________________________

____



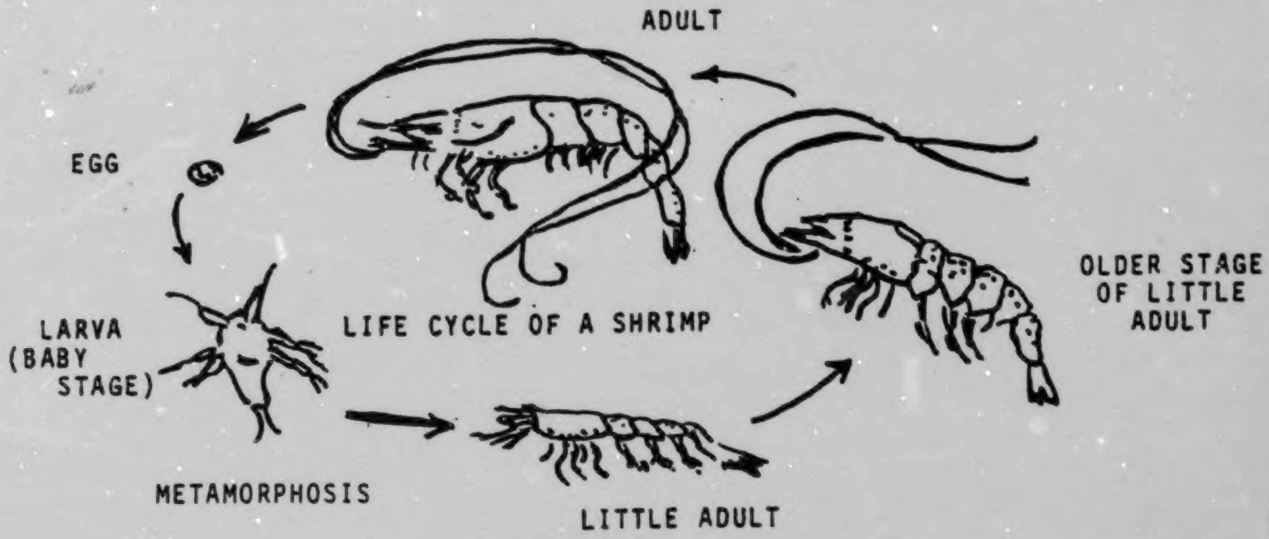
THE SHRIMP

How Do Shrimp Grow?

A single spotted shrimp will produce as many as 3,000 eggs. They spawn from September to November in shallow waters. The female shrimp carries her eggs for about four to five months. Once the eggs hatch, the small larvae (baby stage) drift freely in the water. The baby shrimp will remain larva for 30 to 35 days. The larvae eat phytoplankton (small drifting plants) and zooplankton (small drifting animals.) These baby shrimp themselves are a form of zooplankton.

2. Phytoplankton and zooplankton together are called plankton. What is plankton?____

____


ADULT
EGG
LARVA (BABY STAGE)
LIFE CYCLE OF A SHRIMP
OLDER STAGE OF LITTLE ADULT
METAMORPHOSIS
LITTLE ADULT

When they are about one month old metamorphosis occurs. Metamorphosis means changing form. After metamorphosis the larvae are little adult shrimp. At this time they become scavengers. At about 18 months the spotted shrimp become mature male shrimp.

Once they reach the age of two, the male shrimp change and become female shrimp. By the time they are three to four years old they are able to reproduce eggs. The cycle then begins all over again.

3. Use the following words to fill in the blanks in the sentences below.

LARVA MALE FEMALE EGGS 3,000 30

a. The female shrimp carries her ______________ for 4 to 5 months.

b. Baby shrimp are called ________________ for the first 30 to 35 days after they hatch.

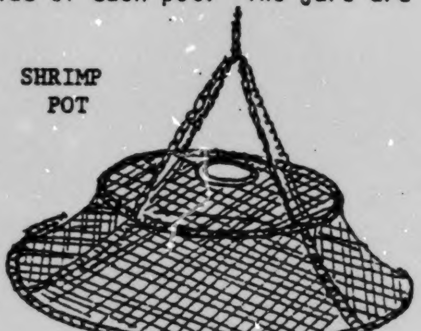
c. A female shrimp lays ____________ eggs at a time.

d. At 18 months the shrimp become mature _______________ shrimp.

e. At 2 years of age the shrimp become mature _______________ shrimp.

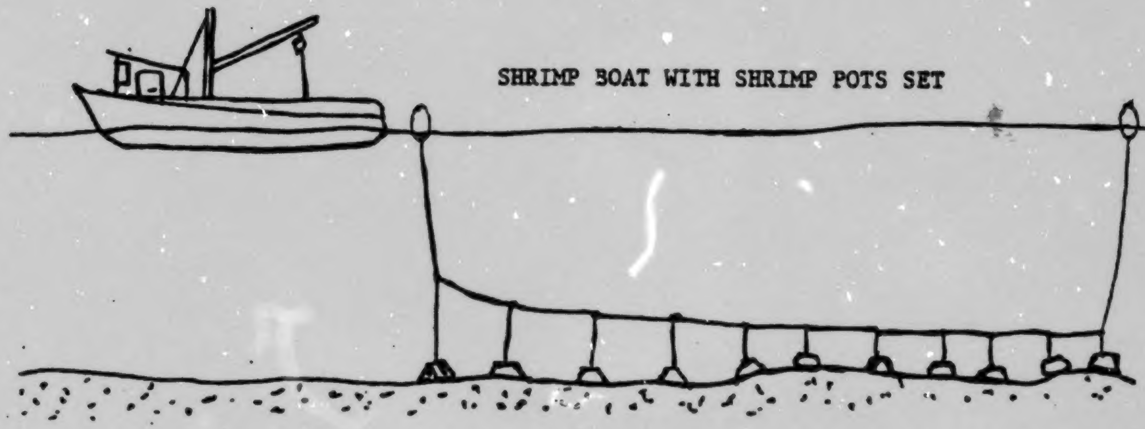
Harvesting the Shrimp

On their boats the shrimpers will have 40 to 200 traps. These traps are called shrimp pots. These pots are about 2½ to 3 feet in diameter. They are 18 inches deep. They are of a heavy wire mesh. The mesh is stretched over a sturdy metal frame. The shrimpers bait these pots. They place two or three jars of bait on the inside of each pot. Two jars are filled with ground fish and often the third jar is filled with cat food. Surprisingly this seems to attract the shrimp.



4. What are the traps for shrimp called? ____________________________

The shrimpers attach about 40 baited pots to one long line using shorter ropes. The pots are placed about seven to ten feet apart. The shrimpers lower the pots into the water at 40 to 600 foot depths.



The shrimpers mark the location by attaching buoys to each end of the long line.

The shrimpers return to the same spot the next day. They collect the equipment and the shrimp. At this point there are several jobs to be done. One person is needed to pilot the boat. Other members of the crew will attach a winch to the main line holding the shrimp pots. The winch pulls the pots on board. One crew member guides the pots onto the boat, Another opens the pots. The shrimp are poured into the hold of the boat where they are packed in ice. The empty pots are then rebaited and stacked to one side. All the pots are brought up. The captain then decides where to replace the shrimp pots.

5. How do the shrimpers find their shrimp pots when they come back for them the next day?______________________________

____

Distribution And Marketing Of Shrimp

Once all the lines have been checked and reset, the catch is brought to shore. Here the catch is sorted. Sometimes small fish and other marine animals are caught in the shrimp pots. They need to be separated from the shrimp. Some of the small fish and other marine animals are ground up. They are used for bait when the pots are set the next day.

The shrimp are boiled in a solution of rock salt and fresh water. Once they are cooked the shrimp are ready for the market. Some of the shrimpers sell their catch directly to a local fish market. Others sell theirs to a fish broker. The fish broker distributes many different kinds of seafood to markets and restaurants in various locations. Nearly all of the shrimp are sold fresh.

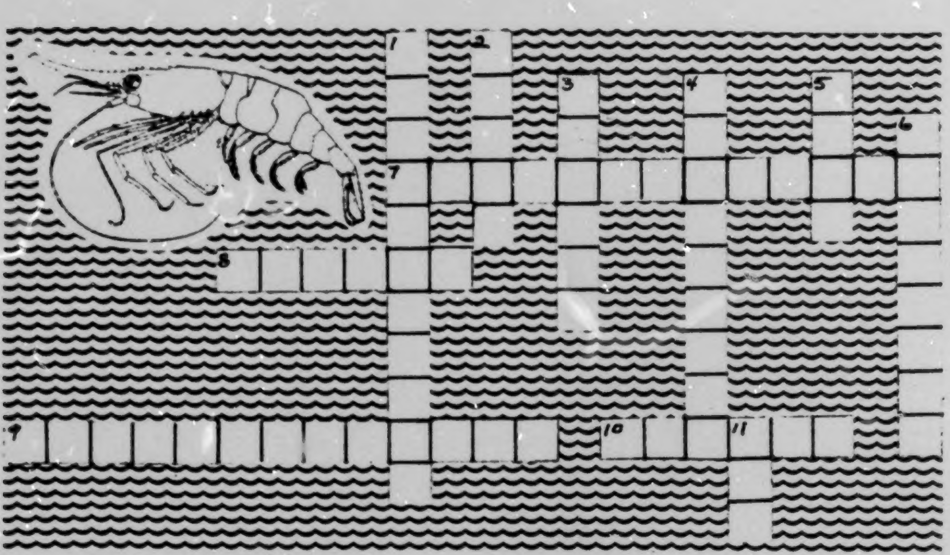
6. What two ways can the shrimper market his crop?

a). ______________________________

b). ______________________________

7. Have you ever eaten shrimp?______________________

PUZZLING SHRIMP



Across

7. Small, drifting plant

8. The baby stage of shrimp

9. Changing form

10. A favorite sea food

Down

1. Small, drifting animals

2. Shrimpers mark pots with these

3. People who buy and sell shrimp

4. These feed on dead organisms

5. Some shrimpers use these

6. Long, whip-like sense organs

11. Shrimp are packed in this

TEACHER BACKGROUND - The Shrimp Boats Are A-Coming.

"The Shrimp Boats Are A Coming" provides your students with some additional information about shrimping while simultaneously providing practice with the set up and solution of simple word problems. The problems follow from the text material. Word problems tend to be avoided by students. Unfortunately, a large percentage of the math skills used in everyday life turn out to be word problems. Since these problems flow from the text, they tend to be easier to comprehend than some other formats.

Duplicate the activity pages. One set is recommended per student. This assignment may be performed by individual students in the classroom or as a homework assignment. Provide your students with any aid and encouragement which they may need to be successful in this endeavor.

KEY

1. Florida, Alambama, Mississippi, Louisiana, and Texas are the states bordering the richest shrimp waters.

2. a. Using the range of lengths given, the average length of shrimp boats is 60 feet (ie. 40' + 80'/2 boats = 60'/boat).

   b. Using the range of water depths given, the average water depth is 47.5 feet (ie. 5' + 90'/2 depths = 47.5' deep).

3. One thousand pounds of shrimp would be in the net (ie. .50 shrimp catch x 2000 pounds total catch = 1000 pounds of shrimp).

4. Forty percent of the shrimp is edible (ie. 100% total shrimp - 60% head = 40% edible remaining).

5. Four hundred pounds of edible shrimp are left after cleaning (ie. 40% edible shrimp x 1000 pounds of shrimp in net).

6. a. At best, the single trawl followed in the text is worth $800 (ie. $2.00/pound x 400 pounds of edible shrimp = $800)

b. If the catch had been improperly iced, the trawl would be worth $600 (ie. 75 value of properly iced x $800 best price = $600) Your students may require some help with this problem.

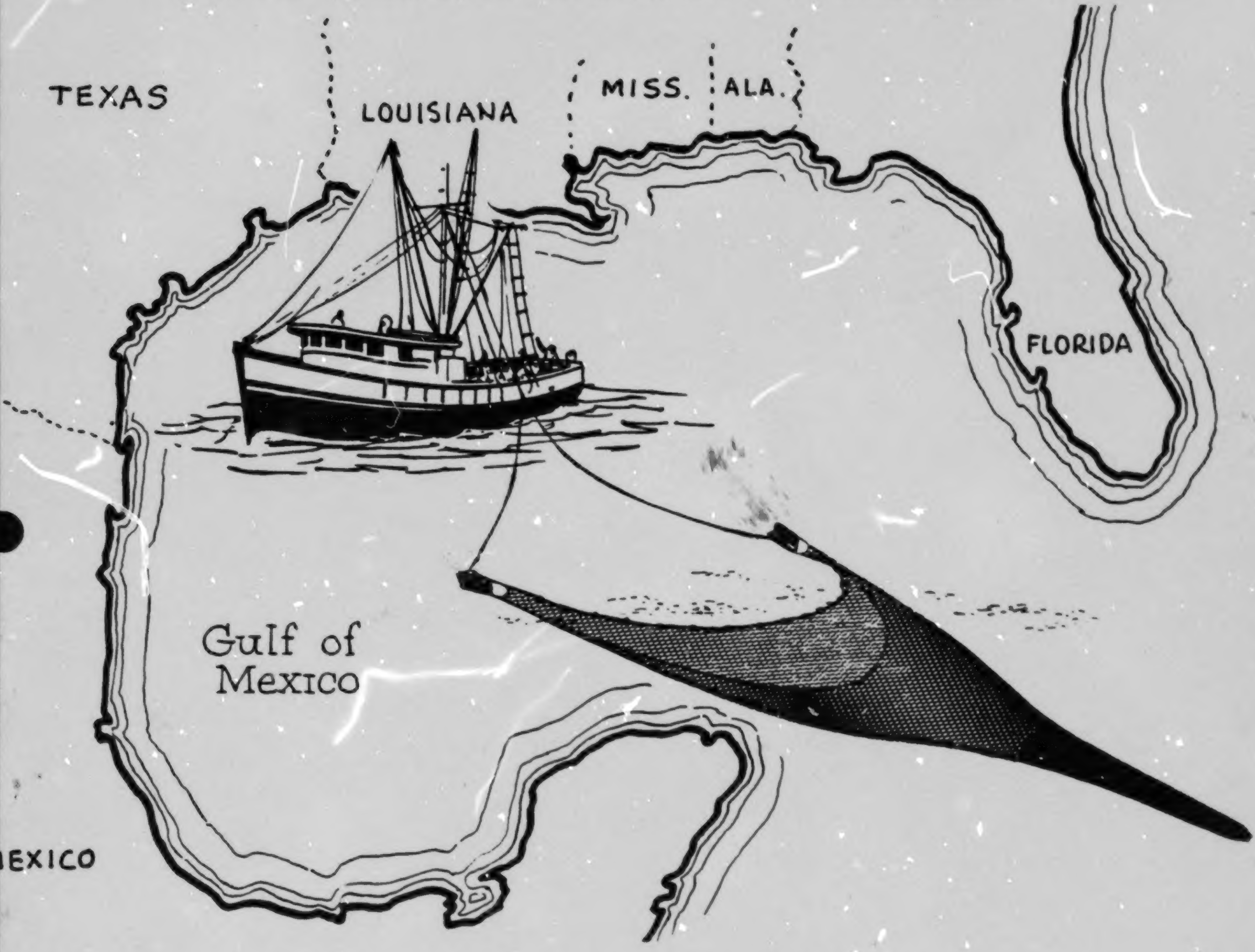
7. As shown in the paragraph preceding this question, many jobs are dependent upon and related to shrimp including: fisher, crew on fishing boat, fishing boat manufacturer, net maker, longshoreman, food handler, packager, trucker, cook, waitress, etc., etc. The point to emphasize is the interdependence of jobs in the intertidal.

KEY

average
beheaded
discarded
edible
gulf states
icing
percent
processing plants
range
trawl
trawl net

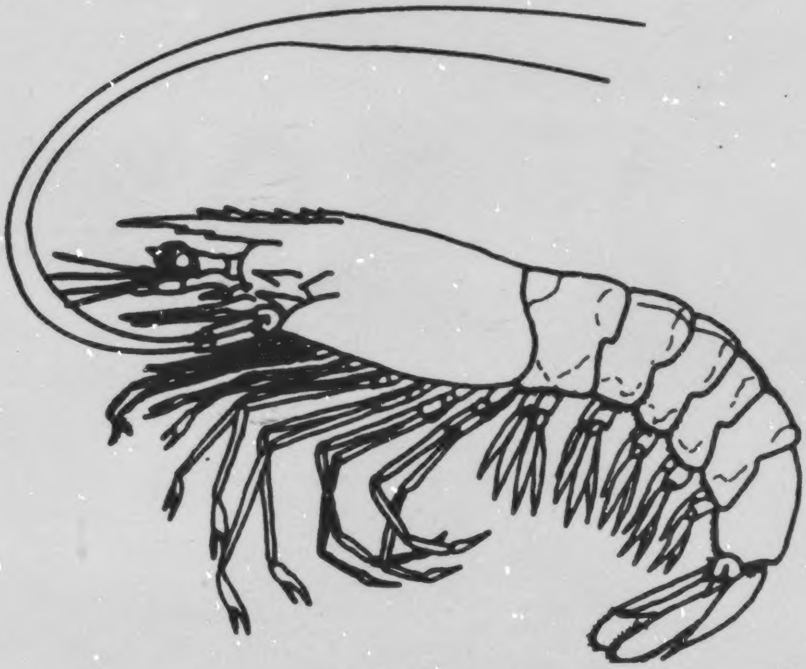
THE SHRIMP BOATS ARE A-COMING

Shrimp live in waters off the Southern Atlantic and Gulf states. These areas produce most of the shrimp sold in the United States.


TEXAS
LOUISIANA
MISS.
ALA.
FLORIDA
Gulf of Mexico
EXICO

1. Which states border the richest shrimp waters?

Some shrimp are less than an inch long. Others are nearly twelve inches in length. Live shrimp come in lots of colors. Some are pink, some white, some brown. What ever the color, they all turn pink with cooking.



Commercial fishers catch shrimp from boats. The boats are usually 40 to 80 feet long. These shrimp boats use a huge trawl net. They drag the huge trawl net along the bottom. The water is from 5 feet to 90 feet deep.

2. a. What is the average length of shrimp boats? (Hint: you can find the average by using this formula:

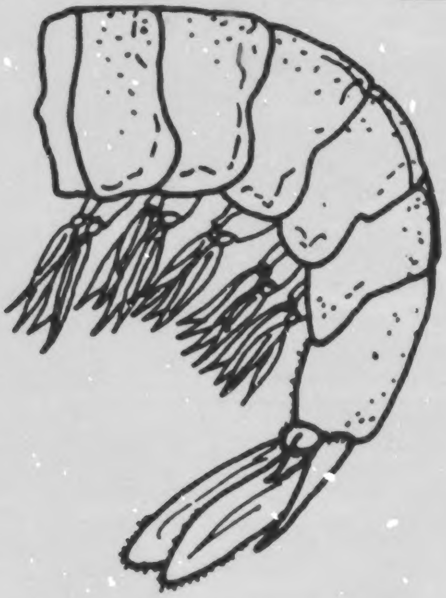
$$\frac{\text{sum of boat lengths}}{\text{number of boats}} = \text{average boat length})$$

   b. What is the average water depth at which shrimp boats trawl? PLEASE SHOW YOUR WORK.

The shrimp boat Thomas James is fishing off the South Texas coast. She drags her net for one hour. the net is hauled in. As the net comes on board, the deck is alive with fish and shrimp. Two thousand pounds of live animals jump and dance in the net. Fifty percent of the catch is shrimp.

3. How many pounds of shrimp are in the net?

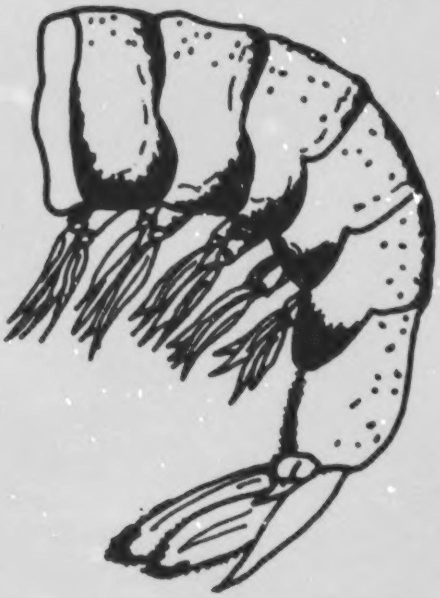
The other fifty percent of the catch is fish. The crew throws the fish back. Shrimp must be beheaded. The head is discarded. The discarded heads account for 60% of the entire shrimp. The headless shrimp must be immediately put on ice. The rest of the shrimp is edible.



4. What percentage of the shrimp is edible?

5. The crew has finished cleaning the catch. How many pounds of edible shrimp are left? (HINT: use your answer from 3 as a starting point.)

Icing the shrimp is very important. Dark spots appear on shrimp that have been poorly iced. The spots are really a sort of sun tan. They do not hurt the taste of the shrimp. They do, however, reduce their sale value.



6. a. The Thomas James has returned to the dock at Corpus Cristi, Texas. The shrimp buyer is paying up to two dollars a pound. At best, how much was the catch worth?

b. The buyer pays 25% less for shrimp with black spots. Sad, but the catch has been improperly iced. How much is the trawl worth?

The shrimp leave the boats. Many other people will make a living from them. People working on the docks move the shrimp. People working in processing plants ready the shrimp for market. Shrimp are sold fresh, cooked, canned, or frozen. Other people transport the shrimp to stores and restaurants. Still other people, prepare the shrimp for their final destination: your stomach!

7. What are three jobs which depend upon shrimp?

TEACHER BACKGROUND - How Hot is Too Hot

It is important to start the investigation when you are sure the class will meet for four consecutive days so that the readings can be taken. Brine shrimp eggs are easily obtained at tropical fish stores for a small sum. Read the instructions on the container for making the salt solution needed About a 3% salt solution is correct. The shrimp will hatch in solutions from 1% to stauration.

Jar size is not critical. Small beakers will also work. It is important that each group of students doing the exercise have three jars of similar size. Groups of three or four may be used in this experiment.

Jars should be filled to the same level. The number of eggs fitting on the end of a scalpel or a coffee stirrer is about the correct number to place in the jar. Anything that will get you about that number will work. The eggs will float so try to keep them from all sticking to the side of the container.

Observations should be made at the same time each day. The observations can be made in about 15 minutes. The students need to take the temperature of the water and count the number of shrimp larva. The absolute numbers are not critical. You need to determine relative numbers.

KEY

1. The answers depend upon the results. Usually the room temperature works the best, the refrigerator has the fewest.

2.& 3. Depends upon the results. Discuss possible reasons for the results obtained. This is a good opportunity for creative hypothesizing by your students.

4. Again, depends on results. But usually high and low temperatures will have fewer hatching.

KEY WORDS

adult

brine shrimp

dissecting microscope

environment

experiment

hand lens

hatching

label

larva

life cycle

observe

record

refrigerator

relatives

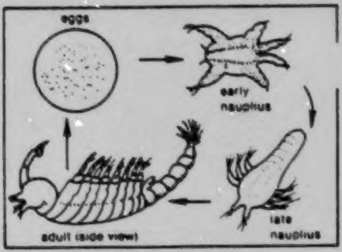
scale

solution

spatula

temperature

thermometer



HOW HOT IS TOO HOT?

Living things must deal with changes in their environment. Things such as temperature may change a great deal. Let's look at how different temperatures affect brine shrimp eggs.

Brine shrimp are relatives of the shrimp caught for food. They are often used as a fish food by people with pet fish. The life cycle of the brine shrimp has three stages: egg, larva, and adult. Even as an adult the brine shrimp is less than one inch long.

In this experiment you will be observing the hatching of brine shrimp eggs.

MATERIALS

Brine shrimp eggs

3 Baby food jars or similar containers

Electric Lamp

Marking pencil or labels

Refrigerator

Thermometer

Hand lens or dissecting microscope

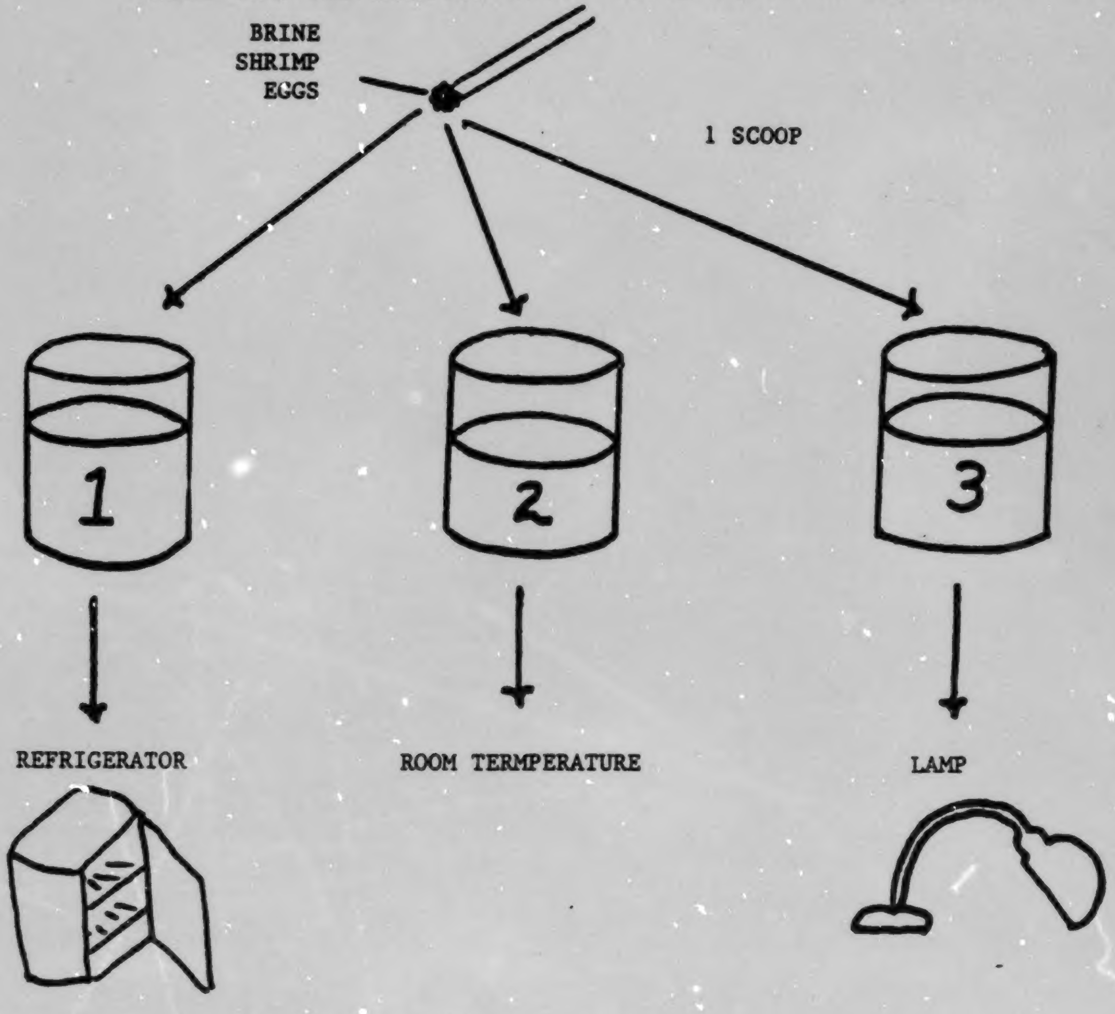
Coffee stirring stick or spatula

Salt water solution

METHOD

1. Obtain three jars. Mark or label the jars one, two and three.
2. Fill the jars about 3/4 full with salt solution.
3. Place into each jar as many brine shrimp eggs as you can put on the end of a coffee stirring stick or small spatula. Gently tap the stick against the side of the jar to remove the eggs. DO NOT let the spatula touch the solution.

4. Stir the eggs into the water in each jar.
5. Place jar number one in the box labeled "refrigerator".
6. Place jar number two in the spot your teacher has provided for those jars to be left at room temperature.
7. Place jar number three beneath the electric lamp.
8. For the next 4 days, observe the jars using your hand lens. Record the findings in the tables provided. Record the number of shrimp hatched and the temperature of the water. To find the temperature, put the thermometer into the jar for 1 minute then read the scale. Read the thermometer while it is still in the water.


BRINE SHRIMP EGGS
1 SCOOP
1
2
3
REFRIGERATOR
ROOM TERMPERATURE
LAMP

	REFRIGERATOR JAR #1		ROOM TERMPERATURE JAR #2		LAMP JAR #3	
	Number Hatched	Temperature	Number Hatched	Temperature	Number Hatched	Temperature
DAY 1						
DAY 2						
DAY 3						
DAY 4						

RESULTS

1. Did any of the eggs hatch after the first day? ____________
   If they did hatch, in which temperature did they hatch?

   ____

2. Which jar had the most shrimp hatch? ____________________________
   What was the temperature of the jar with the most shrimp hatching? ______________________

3. Which jar had the fewest shrimp hatch? ________________________
   What was the temperature of the jar with the lowest shrimp hatching? ___________________

4. Make a general statment about the effect of temperature on shrimp hatching. (Hint: A general statment might be: More shrimp hatch in boiling water than in ice water.

   ____

   ____

   ____

   ____

TEACHER BACKGROUND - Only Half The Story

This exercise helps to improve reading skills through the use of modified CLOZURE procedure. The exercise also serves to reinforce some of the key vocabulary from the text. Students may work on the activity individually, then compare results with others in a small group, or they may work in small groups from the onset. Be sure to take a few minutes to review the correct answers.

KEY - answers

A favorite seafood of many people is SHRIMP. Shrimp are SCAVENGERS, feeding on dead and decaying plants and animals. Female shrimp lay eggs which hatch into free drifting LARVA. The baby shrimp remain larva for about one month. At the end of this time METAMORPHOSIS, which means changing form, occurs.
Shrimp are very unusual because at about two years of age the male shrimp change and become FEMALE shrimp. Amazing!

Shrimp are captured in traps called SHRIMP POTS. The pots are filled with bait and placed on the ocean bottom. The shrimp can get into the pot but they can't get out. Harvested shrimp are BOILED in rock salt and water. Once they are cooked they are ready for dinner table.

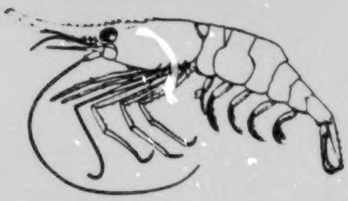
KEY WORDS

larva

metamorphosis

scavengers

shrimp pots



ONLY HALF THE STORY

The story below needs your help. Write in the missing words. Several words are missing. Use the list of words below the story to fill in the blanks. Put the word that makes most sense in each blank.

A favorite seafood of many people is __________________. Shrimp are ______________________, feeding on dead and decaying plants and animals.

Female shrimp lay eggs which hatch into free drifting ________________.

The baby shrimp remain larva for about one month. At the end of this time___________________________, which means changing form, occurs.

Shrimp are very unusual because at about two years of age the male shrimp change and become ____________shrimp. Amazing!

Shrimp are captured in traps called_______________________. The pots are filled with bait and placed on the ocean bottom. The shrimp can get into the pot but they can't get out. Harvested shrimp are ___________________in rock salt and water. Once they are cooked they are ready for your dinner table.

BOILED
FEMALE
LARVA
METAMORPHOSIS
SCAVENGERS
SHRIMP
SHRIMP POTS

SUGGESTED ADDITIONAL ACTIVITIES

1. Take a trip to a local seafood market.
2. Draw a picture of a mature male shrimp.
3. Visit a shrimp boat.
4. Interview a shrimper.
5. Draw a shrimp larva.
6. Imitate the movements of a shrimp.
7. Invent a new method for catching shrimp.
8. Make a model of a shrimp pot.
9. Research shrimp in your school library.
10. Write a story about a shrimp named "Pinkie."

COMMERCIAL FISHING

TEACHER BACKGROUND - Commercial Fishing

The commercial fishing section deals with salmon, albacore, halibut and bottomfish. It is somewhat lengthy and may best be utilized by dividing the material over several sessions. There are several ways in which the text may be divided: The salmon, albacore, halibut, and bottomfish may be treated on separate days. The salmon section may be further divided into sessions on each type of fishing gear. The exact divisions will depend upon your time and class. IT IS NECESSARY TO PREVIEW THIS SECTION IN ORDER TO DECIDE THE TEACHING STRATEGY BEST SUITED TO YOUR PARTICULAR GROUP.

Make plans to obtain a fresh fish or several fresh fish for the exercise, "Gyotaku - Japanese Fish Printing". Fish need not be large. It is best if each student has an opportunity to make and keep a print. Thick water-based inks are best for beginning fish printers. Water-based linoleum block printing ink is excellent and easy to use. Black is a good color to work with, but you may want to try such other dark colors as brown, red, green or blue. It is best to do this exercise yourself prior to having the whole class undertake it.

Duplicate the pages of the text and the activity. One set is recommended per student.

KEY

1. Your students will have a variety of explanations including: over fishing, increases in human activities on stream (dams, houses, roads), and pollution. All of their ideas are worthy of discussion and probably contribute to the answer to a really complex problem.

2.-3. Salmon are born and die in upland, fresh water streams.

4. The two boats used in purse seining are

   a) seiners, and

   b) seine skiffs

5. The three lines on a seine net are

   a) cork line

   b) lead line, and

   c) purse line

6. Whales can usually escape gill nets by destroying the nets. This question is designed to further your students' thinking about the relationship between mesh size and catch size.

7. This is a rather open-ended question. George will have to look harder and maybe buy a new net. So, he will be out money and fishing time. But what happens to the net? The net which is made of strong mesh will go on catching fish without George's presence. This perpetual (or long term) trap is said to "ghost fish" since fish continually become entangled and die. New nets have panels that rot after prolonged time in the water to reduce ghost fishing.

8. Troll caught fish are physically more attractive (fewer bruises and lost scales) and are usually sold whole and fresh or frozen in markets where appearance matters and is paid for.

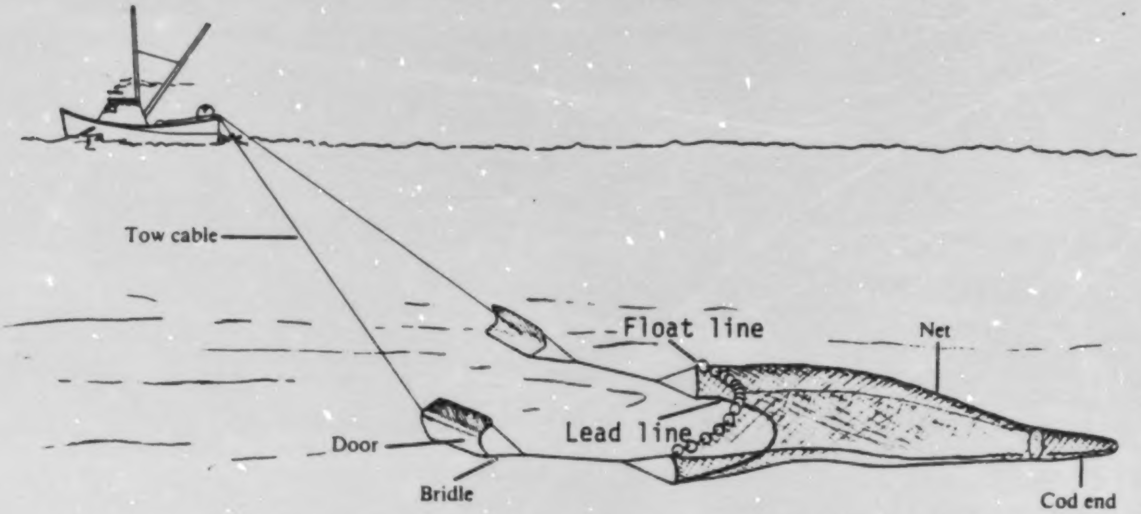
9. Albacore is a kind of tuna.

10. Halibut eggs develop as they drift in the open sea.

11. If the anchors fell off the skate line, the line would drift away and likely be lost. The drifting line could also become a ghost fisher.

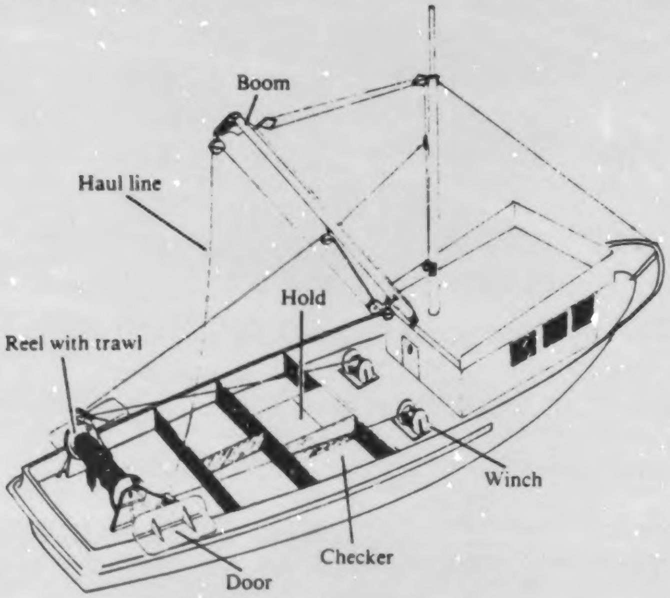
12. Fisher Barbara is going fishing for sole. She should set her net in the bottom third of the ocean. (The correct answer is underlined).

13.-14. The picture below shows a correctly labeled trawl net.


Tow cable
Float line
Net
Lead line
Door
Bridle
Cod end

15. The lead line, float line and otter doors are the three parts of the trawl net which help hold the net open. The lead line pulls the bottom of the net mouth down, the float line pulls the top up, and the otter doors pull the sides outward as the net moves through the water.

16. a.-b. The picture below shows a correctly labeled trawler.


Boom
Haul line
Hold
Reel with trawl
Winch
Checker
Door

17. Draggers work in water from 10 to 500 fathoms deep. A fathom equals six feet. How deep is the water in feet?
Sixty to 3,000 feet deep. (The correct answers are underlined) The work should look something like the following:

10 fathoms x 6 feet/fathom = 60 feet and,
500 fathoms x 6 feet/fathom = 3,000 feet.

18. Fish smaller than 5" around can escape 5" net mesh.

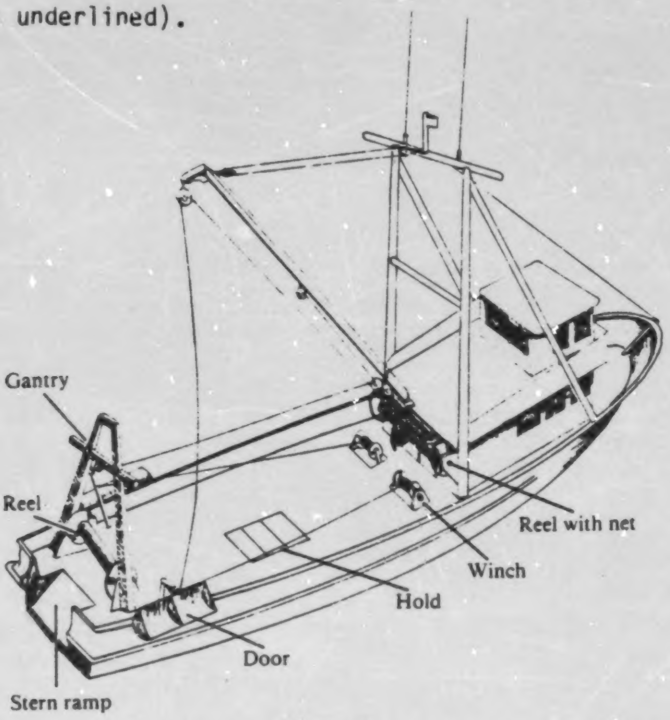
The object of this question is to start a discussion on the effects of different net mesh sizes on the catch. Smaller mesh nets catch more small fish with possible adverse effects on the fish populations. The regulation of net mesh sizes is an important fisheries management tool.

19. Fish smaller than 5" around may escape 5" net mesh.

20. The lead line drags along the bottom and stirs up the fish. The fish rise to escape and are captured.

21. A good trawl can bring up 30 tons of bottom fish as noted in the text above this question. Thirty tons is 60,000 pounds of fish, not bad for a single set! This question requires your students to locate the information in the text and then multiply 30 tons of fish/good trawl x 2000 pounds per ton = 60,000 pounds of fish/good trawl.

22. a. The picture below shows a stern trawler. (The correct answer is underlined).


Gantry
Reel
Reel with net
Winch
Hold
Door
Stern ramp

b. The net on the midwater trawler is located forward behind the cabin while the net on the bottom dragger is located at the very stern.

c. Bottom draggers trawl from thirty minutes to several hours. This question is designed to get your students to scan upwards through the text material in a brief review while looking for the information.

23. Many students will have eaten salmon.

24. Most salmon flesh is pink. However, some salmon flesh is white and some almost red.

25. From the text, your students should be able to determine at this point that trawl fish are marketed as fresh "white fish" and as frozen fish patties.

26. This question can start your students on a detective hunt that can involve the school cafeteria staffs and others. You may be surpised how helpful people want to be.

27. FPC is fish protein concentrate, fish meal made from processed bottom fish and used primarily for farm feed in this country.

28. Plastics, paints, and cosmetics are made from fish oils.

KEY WORDS - Commercial Fisheries

albacore

anchor

aquaculture

biologist

boom

bottom draggers

bottomfish

bow

buoy

"cod" line

cork line

crew

KEY WORDS - Commercial Fishing (cont'd)

dragger

fathom

fish tender

fishing grounds

float line

FPC

gill net

hake

halibut

harvest

herring

hoist

lead line

lure

mainline

midwater

migrate

nylon mesh

octopus

otter door

otter trawl

pollock

population

predators

processor

purse line

purse seine

reel

regulated

salmon

skate line

species

stern

squid

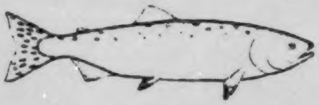
trawlers

troller

weir

winch

Illustrations of fishing gear are from the Sea Grant Marine Advisory publication Leaflet 2272, "Major Commercial Fisheries in California".



COMMERCIAL FISHING

On all of our coasts, commercial fishing is big business. Many different kinds of fish are caught. Many different methods are used to catch these fish. In the Pacific Northwest, salmon, albacore, tuna, and halibut are commercially fished species (kinds). These three fish provide a living for many fishers and packers. Many other fishers catch and sell bottomfish.

Salmon

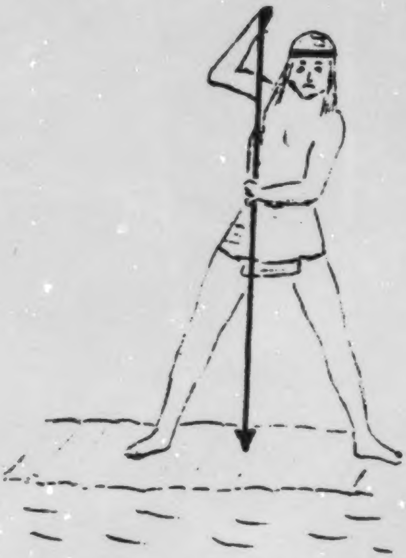
For thousands of years, man has used salmon for food. The Indians fished for salmon in several ways. Some groups used bone and wood hooks. Others used fish weirs, a fence placed in salmon streams. The fence directed the fish into traps. Still others used woven nets to scoop the salmon from the streams. The human population has increased in the Pacific Northwest. The salmon population has decreased. The old methods are no longer used by commercial fishermen.

1. Can you explain why the salmon population decreased? ______________________________

   ____

   ____

Salmon are one of the post popular fish with sports fishermen. Commercial salmon fishing is very important. It plays a major role in the economy of many Pacific coastal areas.



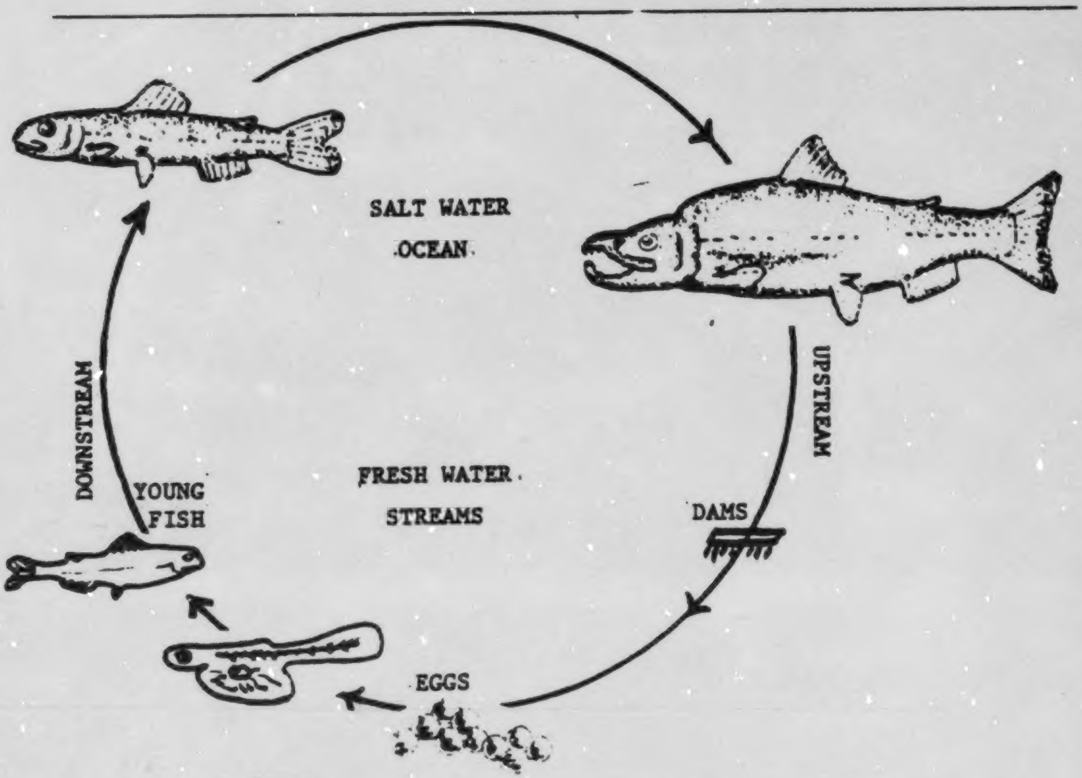
INDIAN SPEARING SALMON

LIFE HISTORY OF THE SALMON

Salmon begin life as eggs. The eggs are laid in the clean gravels of upland streams. When the new eggs hatch they remain in fresh water streams. Some eggs remain a few days. Some remain a year and a half. The time depends on the species of salmon. They then migrate to the open sea to find food. In the sea they continue to grow. The young salmon face an exciting trip to the sea. They must avoid dams. They must hide from predators on their trip. The salmon remain in the open ocean for two to four years. Biologists are just beginning to find out what the salmon do during their time at sea. The salmon increase in size. Finally they are ready to begin their homeward migration. They seek to return to the rivers where they were born. They want to lay their eggs in the same rivers. Again the salmon must face an exciting trip. They must swim around dams. They have to jump over waterfalls. Also they must avoid being caught. Once they lay their eggs, they soon die.

2. Where is the salmon born? ______________________________

3. Where does the salmon die? ______________________________

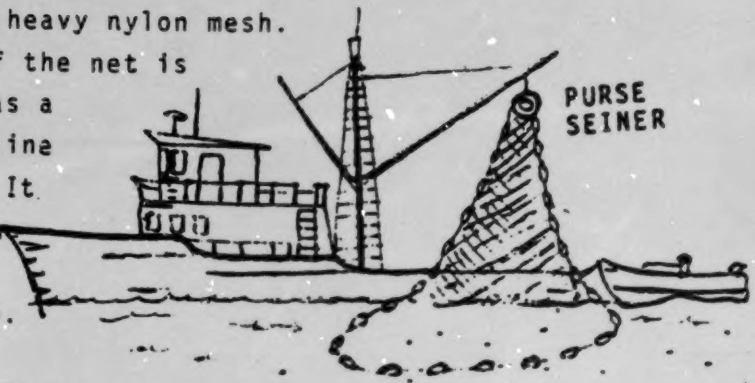


The Pacific Northwest is great for salmon fishing. There are three main methods of commercial salmon fishing. They are purse seining, gill netting, and trolling.

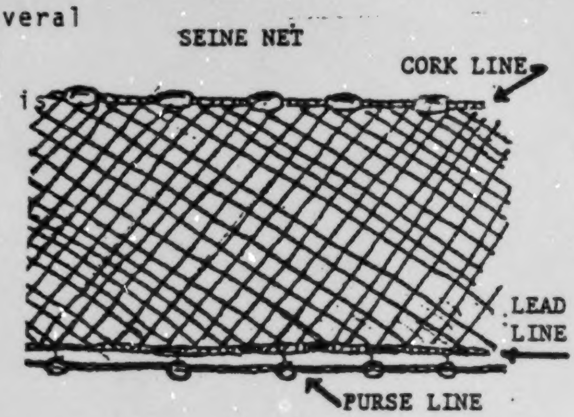
Purse Seine Fishing

Purse seine fishing involves two boats. One is a large fishing boat called the seiner. The other is a small boat called a seine skiff. Purse seining requires five to six people. The nets are carried on the stern of the seiner. The skiff is towed behind the large boat.

The net is made of a heavy nylon mesh. A rope along the bottom of the net is made of heavy lead. It has a material covering. This line is called the lead line. It is used to sink the bottom part of the net. The top of the net also has a rope. This rope has cork floats placed along it. It is called the cork line. It keeps the upper part of the net at the surface of the water. These two lines allow the net to hang straight up and down in the water.



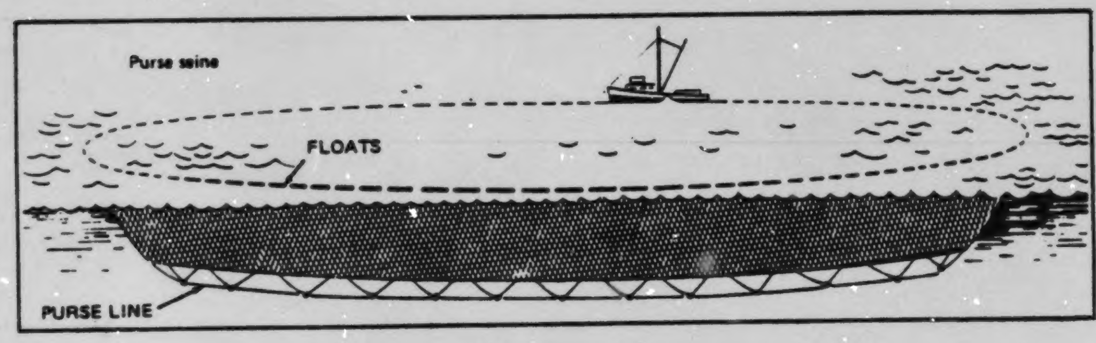
The purse seine net also has a line along side the lead line. This third line slides through several brass rings. The brass rings are tied to the lead line. This line is called a purse line. The purse line is used to draw the net together like a purse string.



4. The two boats used in purse seining are a) ______________________________
and b) ______________________________

5. What are the three lines on a seine net?
a) ________________ b) ____________________ c) ______________________

The captain finds a school of fish. The net is placed around the fish. The small skiff takes one end of the seine net out around the school of fish. The seiner goes in the opposite direction to finish the circle. The seiner begins to tighten the purse line. The net forms a pocket or purse. The fish are trapped inside.



The net is pulled and lifted along side the seiner by a power winch. The fish are then taken out of the seine net. The crew uses a large dip net called a brailer. The brailer swings down from a boom on the boat. The fish are placed in the hold. They are either taken to a cannery or a fish buyer boat.

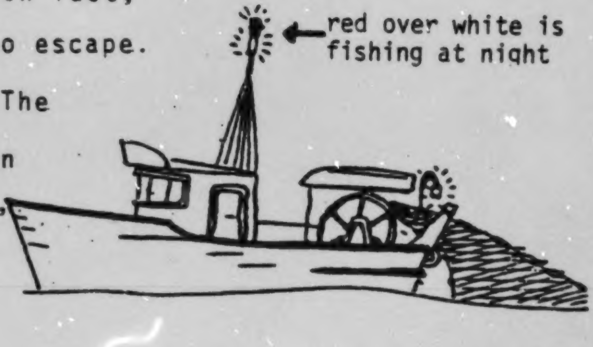
Purse seine fishing season lasts about six months each year in the Puget Sound.

Gill Net Fishing

Gill netting is quite different from purse seining. Gill netting is a one-man operation. The boat is smaller than the purse seiner.

On the stern (back) or bow (front) of the gill netter is a large reel. This is called the power reel. The gill net is wound on this power reel. The gill net is very long. It has a lead line and a cork line like the purse seine.

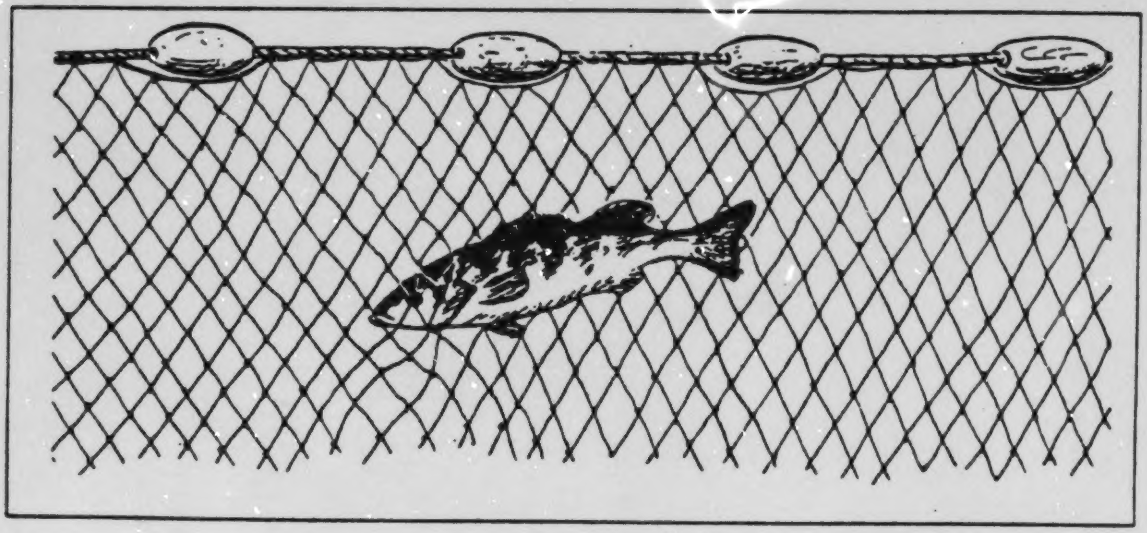
The gill net is also made of a heavy nylon mesh. However the holes in the mesh are almost large enough for the fish to swim through. In fact, some of the smaller fish are allowed to escape. They swim right through these holes. The larger fish, are the fish the fishermen want for selling. These are caught by their gills as they try to swim through the openings.


red over white is fishing at night

A GILL NETTER

6. Can a whale escape a gill net?

____



FISH CAUGHT IN A GILL NET

The gill net is strung out in a straight line behind the boat. It is left there until the fisherman feels enough fish have been caught. The power reel helps pull the net and the fish back into the boat.

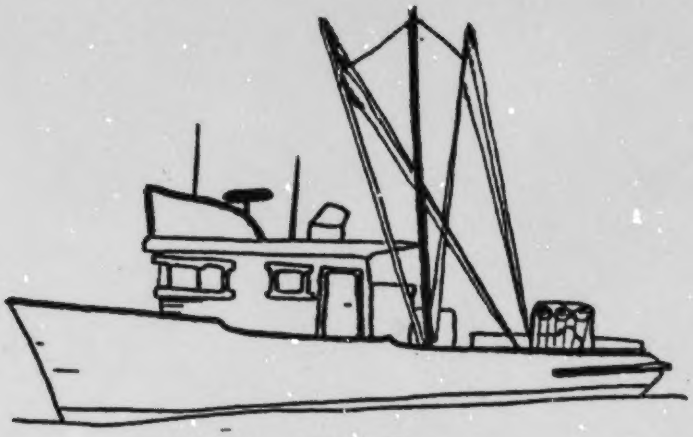
Gill net fishing is usually regulated. They can only fish certain days of the week. Gillnetters fish during the months of May through November. The gill netter fishes from sunset to sunrise. He then takes his fish to a fish buyer. When not fishing, the purse seiner and gill netter are busy. They must repair their nets and boats.

7. George Gillnetter cannot find the net he set. What will happen?____

____

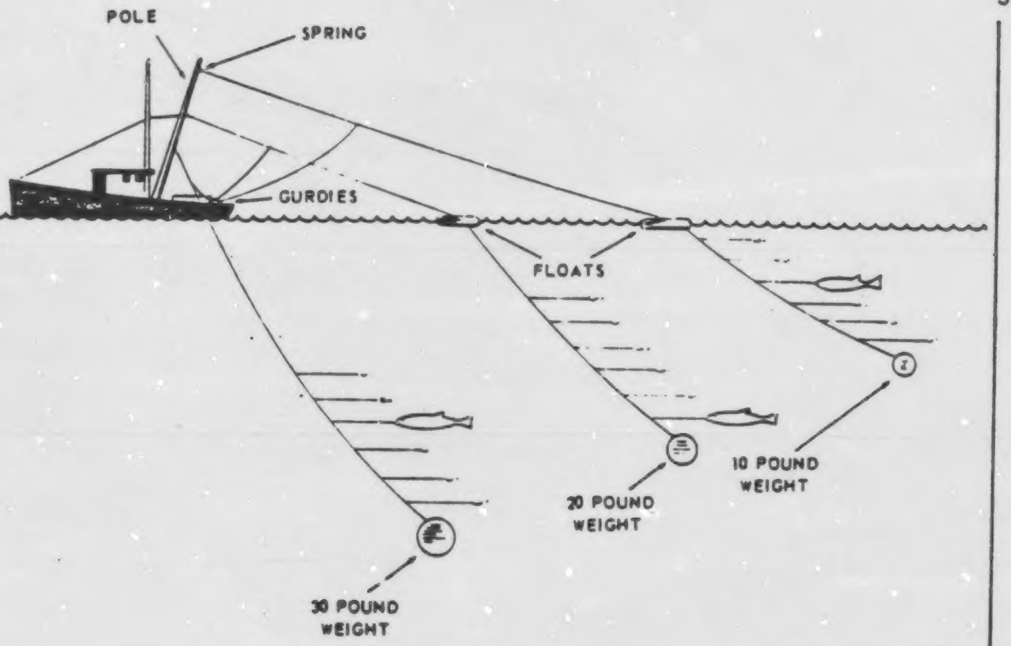
Trolling

Trolling is another important type of commercial fishing. Trollers do not use nets. They fish with long fishing poles. The poles are attached to the boat. They fish up to six main lines at a time. Main lines are weighted with heavy sinkers at the end. There are several short lines tied to each main line. Each short line has one hook. In this way many lines are fishing at one time. The main lines are all around the boat. The fisherman is able to pull in any line at any time.



TROLLER

When the fish are caught, they are cleaned. They are packed in ice right away. Fewer fish are caught by trolling per day than by netting. However, fish harvested by trolling bring a higher price. This is because they are not damaged. They may be selected for the seafood market. Salmon caught by gill netting and purse


POLE
SPRING
GURDIES
FLOATS
10 POUND WEIGHT
20 POUND WEIGHT
30 POUND WEIGHT

Salmon troller

seining may be bruised. They may have lost some of their scales. Damaged fish are processed in a cannery.

Fishing changes from year to year. In one season salmon fishing may be good. In another season or even in a different place salmon fishing may not pay. Because of this the fishermen will often go tuna fishing.

8. Why do troll caught fish cost more? ______________________________

____

Albacore Trolling

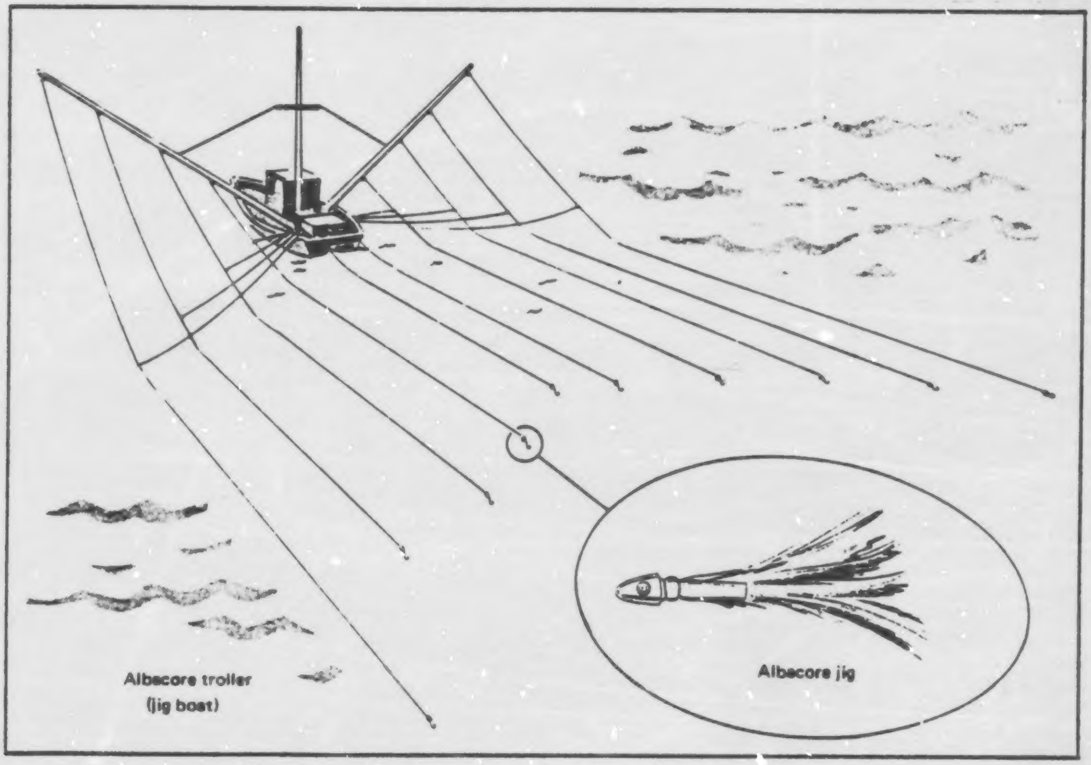
Albacore, are caught in Pacific Northwest waters. Albacore is a species of tuna. Tuna usually travel in large areas of open sea. Tuna fishermen must be prepared to travel. They go hundreds of miles in a season. The salmon boats join the large albacore tuna fleet in late

June or early July. Albacore is the highest grade of tuna. It is always in demand. Albacore is caught by trolling. Live bait or feathered lures (jigs) are used to catch this small tuna.

Every year the fleet searchs for migrating schools of albacore. The fishing usually takes place about 50 or more miles (and often hundreds of miles) offshore. Albacore are caught between Baja California, Mexico and Vancouver Island, Canada.

Some albacore is sold as fresh fish. However, most of this tuna is processed in canneries.

9. What is albacore?____



Halibut Fishing

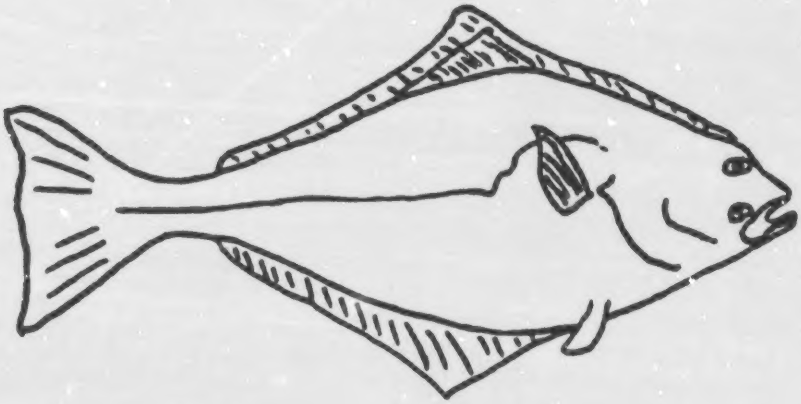
Halibut are a bottom dwelling fish. The North Pacific Coast Indians used a special hook for halibut. Commercial halibut fishing is different from commercial salmon fishing.

Life History Of The Pacific Halibut

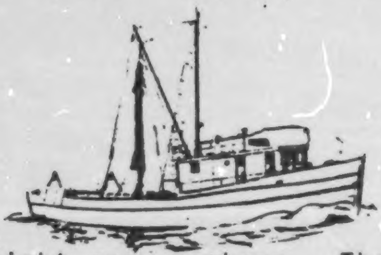
Large numbers of Pacific halibut are found in the North Pacific Ocean. Halibut live in waters up to depths of 600 fathoms. A fathom is 6 feet. From November to January the female halibut lay their eggs. A 140 pound female may have as many as 2,700,000 (two million seven hundred thousand) eggs. The eggs drift as they develop. Many are eaten. Eventually, the developed eggs drop to the low bottom. They have become young fish. The young fish increase in size. They then move to deeper waters. Halibut eat fish, crabs, clams and squid. After about 12 years, the halibut are able to lay eggs. The cycle begins again.

10. Where do halibut eggs develop?________________________________

____



PACIFIC HALIBUT

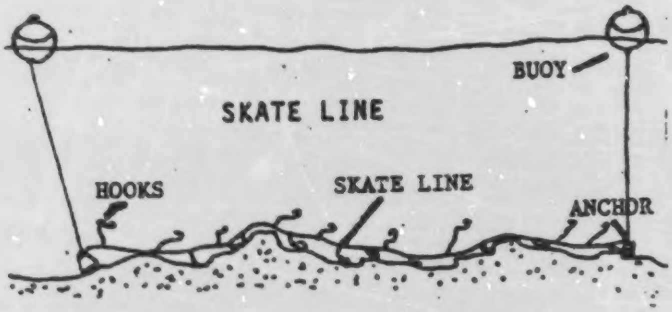


Commercial Fishing For Halibut

Halibut boats have from five to eight crew members. The number depends on the size of the boat. The season for halibut fishing runs from May through September. Halibut are caught from Vancouver Island to as far north as the Bering Sea. The main fishing grounds, however, are off Kodiak Island, Alaska.

The average trip lasts from seven to fifteen days. During this time the crew works long hours. They sometimes work 20 to 22 hours straight. They take time off only to eat.

Halibut fishing is done with long sections of line called "skatelines." Most boats carry from 50 to 60 skates. Each skate is about 300 fathoms long. A fathom is six feet long. A skate line is held near the bottom of the sea floor. An anchor holds the line at each end. The anchors are tied to buoys. The buoys float on the surface. They mark the skate line. The skate line has hooks every 18 to 21 feet. The hooks are baited with herring, salmon, octopus or squid.



11. What would happen if the anchors fell off the skate line?

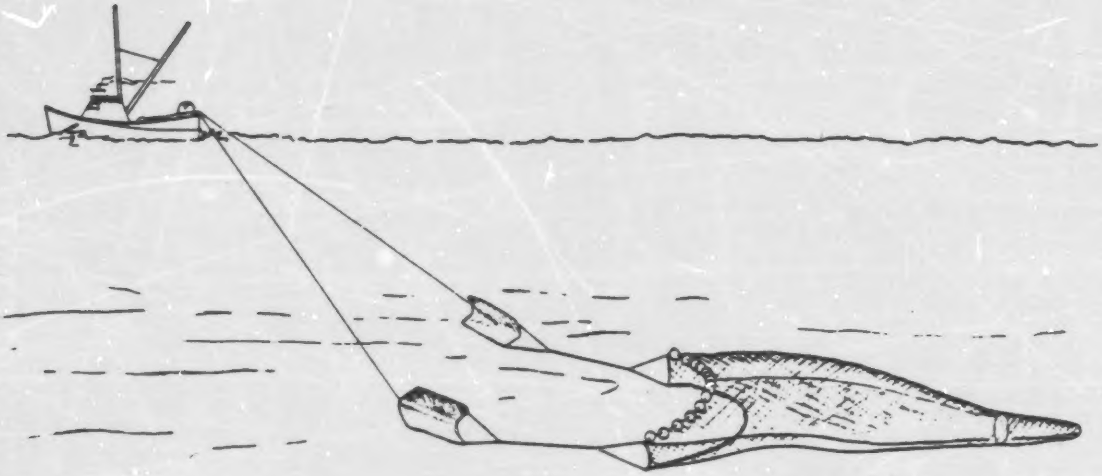
Skate lines may be placed end to end in one row. They may also be placed in rows like a garden. The lines are left in place for up to two days. The length of time depends on how successful the fishing is. The fishermen return. They pick up the skate lines. The halibut are removed from the hooks, cleaned and packed in ice. Later they will be taken to a processing plant. From there they are sent to markets.

BOTTOMFISHING - DRAGGING THE MAIN

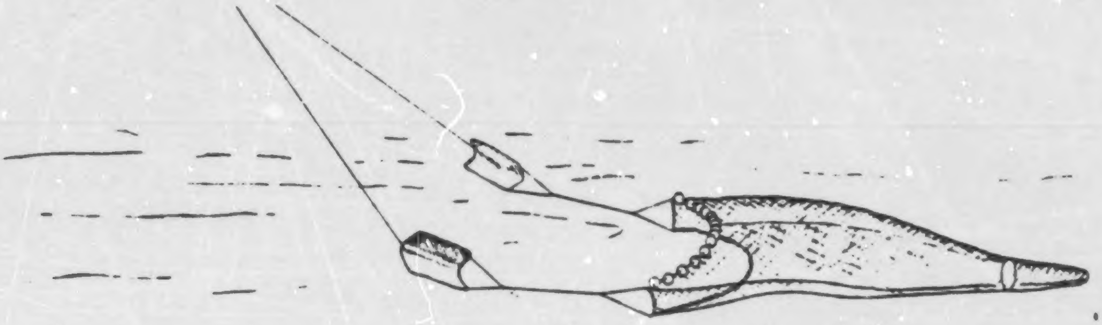
You have seen hooks and nets, skatelines and bouys. There are lots of ways to catch fish. Many fish such as cod, flounder and sole live on the bottom. How do fishers harvest these fish?

12. Fisher Barbara is going fishing for sole. She should set her net in the top/middle/bottom of the ocean. (Circle the correct answer).

Fishers have developed special boats and nets to catch bottomfish. The boats are called bottom draggers or trawlers. The nets are called otter trawls. Let's look at the nets first. Most nets are made to catch particular groups of bottomfish.



The otter trawl is a funnel-shaped net. The net is towed through the water. The net is wide at the mouth. It tapers back to the narrow "cod" end. The cod end collects the fish or shrimp catch. Trawls can be over 100 feet across. Some trawls are over 150 feet long.



13. Label the cod end of the otter trawl shown in the picture above.

Fishers tow trawl nets on the ocean floor. They travel at 2 to 4 knots (4.6 to 6.9 miles per hour).

At the front, an "otter door" is attached to each side. The sides are called "wings". The doors keep the net spread open during the tow. The doors work like a kite. They sail through the water. The sides of the trawl "fly" away from each other.

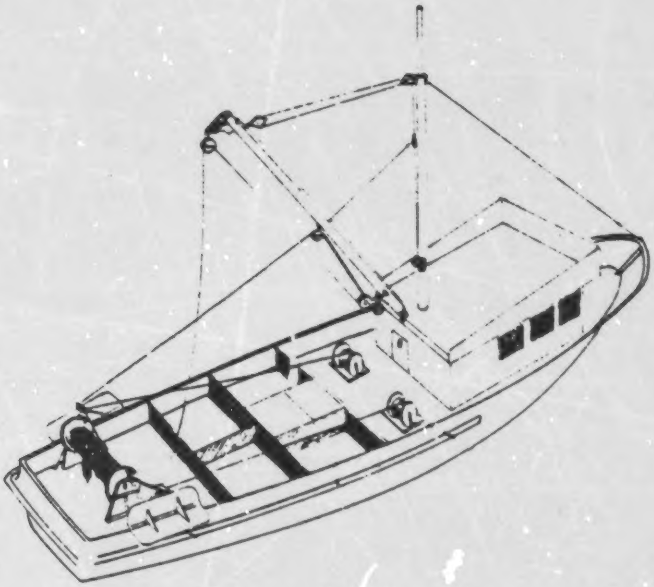
14. Label the otter doors and wings on the picture above.

Two other things help hold the trawl net open. The lead line forms the bottom of the mouth of the net. The weight pulls the bottom of the net down. The float line makes up the top of the mouth. The floats pull the top of the net up.

15. Which three parts of the net help hold the net open?

a.
b.
c.

Many commercial trawlers have square sterns. Remember that the stern is the "back" of the boat. The stern may have a sloping ramp. These boats are called "stern trawlers". Nets are hauled up the ramp. Trawlers without ramps haul the nets over the side. The picture below shows a typical trawler.



How do fishers use trawl nets and trawlers to catch fish? The net is kept on a stern mounted reel. The doors are stored near the reel. The crew sets the net off the stern. They unwind the net from the reel into the water. The cod end goes into the water first. The boat keeps moving ahead. The movement pulls the net off the reel.

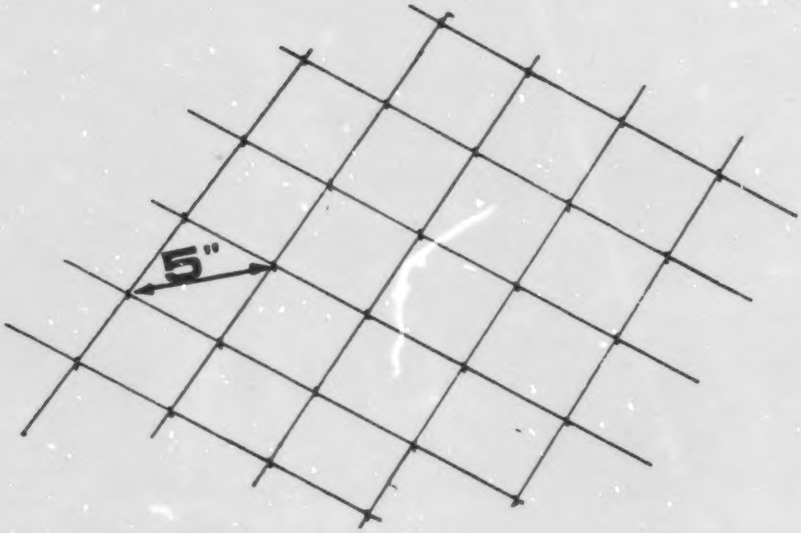
16. a. On the picture of the trawler, mark the reel with an X.

    b. Circle the two doors on the same picture.

The doors are next lowered into the water. The crew releases cable from the winches. After the net is lowered, the boat towes it along. The nets are towed from 30 minutes to several hours.

17. Draggers work in water from 10 to 500 fathoms deep. A fathom equals six feet. How deep is the water in feet? ______ to _____ feet deep. Please show your work.

18. The nets have a 5 inch mesh. This means the "holes" in the net are 5 inches from corner to corner. The drawing below shows a portion of a net.



19. Fish bigger/smaller (circle the correct answer) than 5" around may escape 5" net mesh.

The lead line drags along the bottom. The fish rise to escape. Usually, they dart into the mouth of the net. Once inside the net, the fish's escape routes are few.

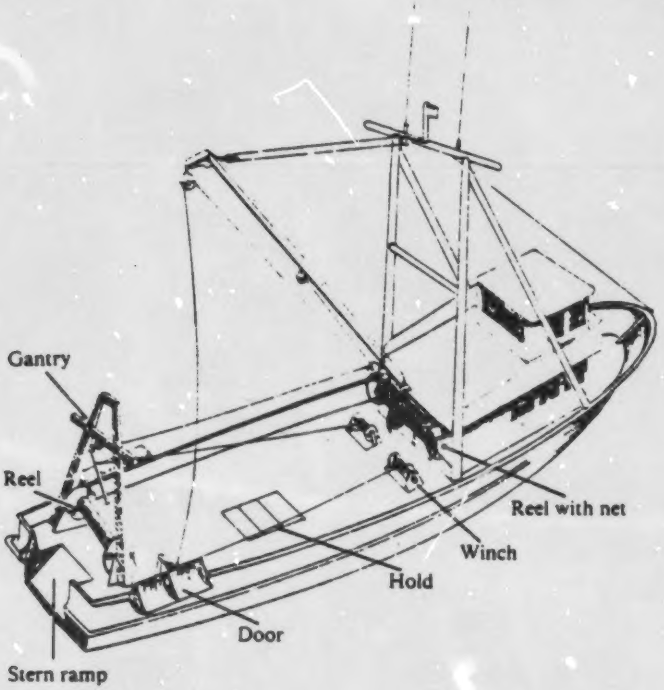
The crew next hauls the net on board. They wind in the cables with the winches. Soon the doors and most of the net come aboard. Finally, the cod end is hoisted up and aboard. The draw-rope which closes the cod end is loosened. The fish spill onto the deck.

Now the catch is aboard. The crew resets the net for another tow. Then they separate the fish by species (kinds). Fish are placed in deck bins or "checkers". To keep them fresh, fish are iced or refrigerated. One good tow can bring up 30 tons of bottom fish.

20. The lead line helps hold the net open. What else does the lead line do as it moves along the bottom?

21. Five to ten thousand pounds of fish are often on one trawl. How many pounds of fish can a good tow bring up? (Hint: one ton = 2,000 pounds) Please show your work. Look in the text above and remember.

22. Midwater trawlers look like the one pictured below. They trawl as deep as just above the sea floor. Or they trawl as shallow as just below the surface. Use this drawing to help answer the following questions.



a. The picture shows/does not show (circle the correct answer) a stern trawler.

b. Where is the net on a midwater trawler? On a bottom dragger?

c. Electronic equipment helps the crew to find the fish. Midwater trawls last only 10 to 30 minutes. How long do bottom draggers trawl?

PACIFIC
FRESH
SALMON

Marketing And Distribution

Catching the fish is just the beginning. How does the fish get to your dinner table? Let's look at the salmon fisherman. After a good day's fishing, the hold of the boat is filled with fish. Sometimes the fisherman may not want to return to the docks The fishing may be too good. He can sell his fish to a fish buyer boat at sea. The buyer then takes the fish into shore. The fisherman who takes his fish into the processing plant gets a slightly higher price. However, he loses valuable fishing time.

The salmon are "off loaded" at the dock. They are put in large metal trays on wheels. The fish are weighed and separated. The next stop is the cutting tables. There the fish are cleaned They are then ready to be canned or frozen. Some of the cleaned salmon are sold as fresh fish. The "fresh" salmon are iced and shipped. They are sent out to markets immediately. The salmon to be canned is cut into can-sized pieces. The pieces are put into the cans. The fish is cooked in the cans. The cans are cooled and labeled. The canned salmon is shipped to stores by truck. The salmon is sold world wide. Salmon is a much sought after food.

23 . Have you ever eaten salmon?________________________________

24 . What color was it? ____

Albacore tuna is processed the same way as salmon. Most of the albacore is sold in cans. A small amount is sold as fresh fish. Halibut is sold as frozen fish rather than canned. Freezer trucks deliver the halibut to dealers. Do you eat fish often? Think of all the people who had a hand in getting the fish from the ocean to your plate. Next time you are in the grocery store, look for the canned fish department. What kinds of salmon are availble? Where did the salmon come from? Look for albacore tuna. What is the price of the albacore tuna compared to the price of other kinds of tuna? Look in the frozen food section for halibut. What is the price per pound for halibut?

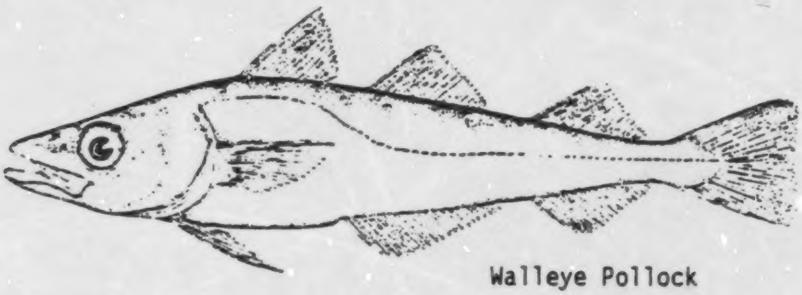
You probably have seen tuna and salmon in the market. You may not have seen "bottomfish". Perhaps you have seen "white fish". Some trawl caught fish is old as fresh "white fish". What, then, happens to all of the trawl caught fish?

Next time you're eating a "Fillet of Fish" sandwich, stop. Where does your favorite fast food restaurant get the fish? Thank the trawl fishers who caught the fish. Thank the workers who removed the bones. Thank the processor who formed the fish into patties. Thank the trucker who carried the fish to the restaurant. Thank the chef. Thank the salesperson who sold you the sandwich. Wow, what a lot of people involved to get the "Fillet of Fish" to you.

25. What are two forms in which trawl-caught fish are marketed?

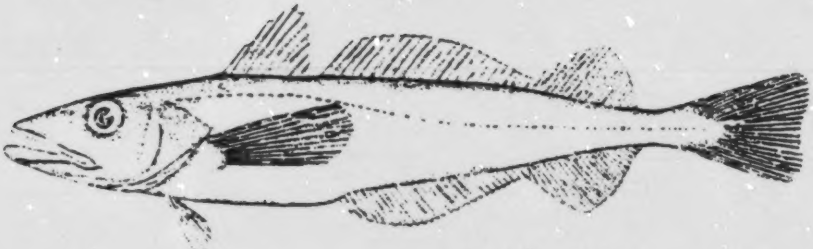
a.
b.

Fish sticks and countless other frozen fish products are made from trawl caught fish. Read the labels on your favorite frozen fish. Pollock and hake are common trawl caught fish used for frozen food.



Walleye Pollock

26. Does your school have a hot lunch program? _____ If so, what kind of fish are you eating? _____ Don't know? How might you find out?



Pacific Hake

Other trawl-caught fish have a less glorious fate. Some trawl fish are sent through rollers. These rollers press the oils from the fish. The solid fish left is called Fish Protein Concentrate or FPC. FPC hasn't caught on as human food. It is, however, a valuable food for poultry, cattle, and hogs. Interestingly enough, FPC is also used in aquaculture projects. FPC is used as food to raise other fish and shellfish. The oils pressed from these fish are very useful. They are made into plastics, paints, cosmetics and other products.

27. What is FPC?

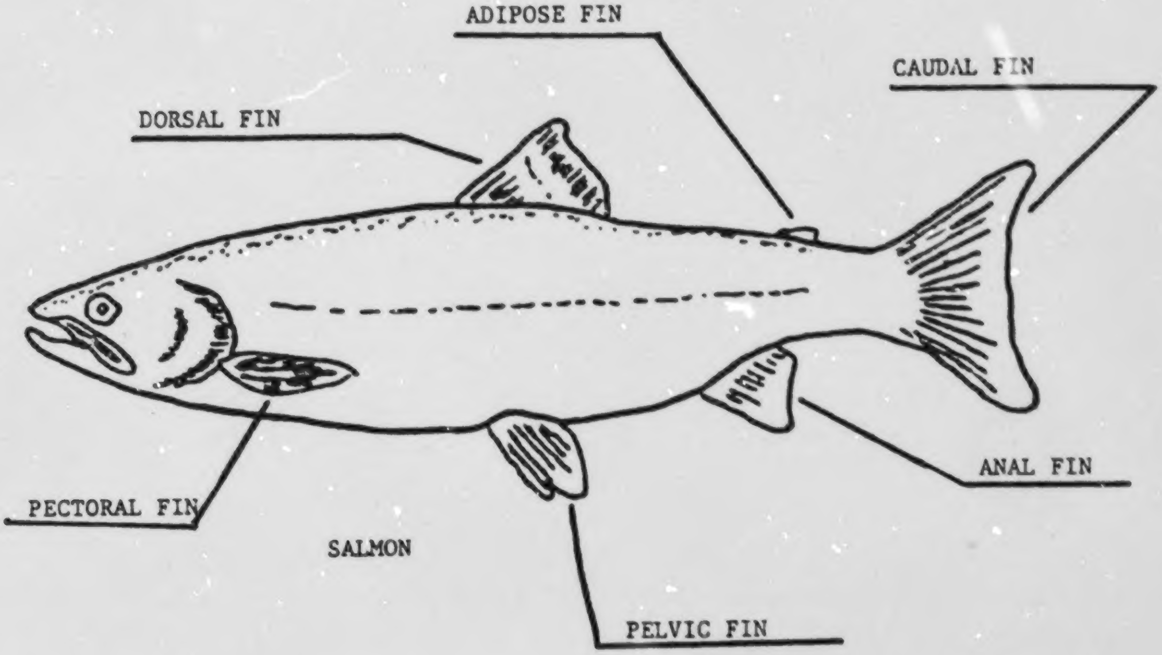
28. What kinds of things are made from fish oils?

Fish are good to eat and good for you. Next time you go shopping take along a pencil and paper. Write down the different ways fish are sold in your store. Keep your eyes open. Be sure to look in all the different areas of the store! Pick out your favorite fish. Why don't you have it for dinner tonight?

TEACHER BACKGROUND - Fins

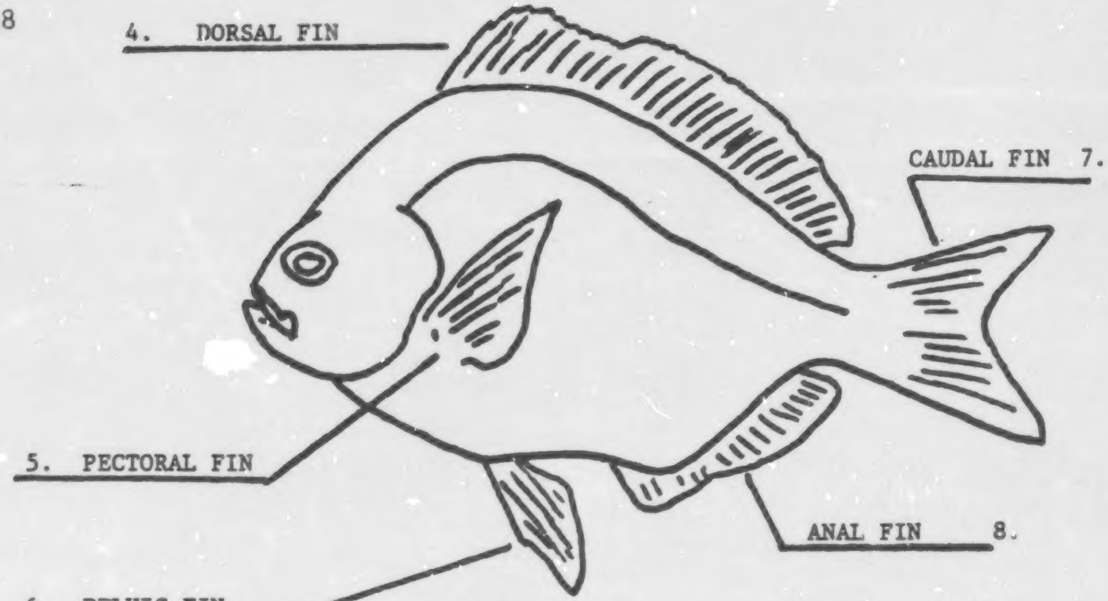
Fish are amazingly well adapted creatures. This exercise is designed to show how the fins on a fish are arranged and how they help the fish to survive. The exercise can be supplemented by observations of fish in aquaria. The living fish is still the best place to observe fins. Before beginning the exercise with your class, read the student activity and study the diagrams of the fish. The function and location of each fin will be found in the text.

KEY - Answers



SALMON

1. The salmon has six kinds of fins.
2. The pelvic fins and the pectoral fins are paired. (Paired pelvic fins are shown. The student must extrapolate about the existence of the second pectoral fin.)
3. The salmon has eight fins total.


4. DORSAL FIN
CAUDAL FIN 7.
5. PECTORAL FIN
ANAL FIN 8.
6. PELVIC FIN

OCEAN PERCH

9. The adipose fin is missing on the ocean perch.

10. This is somewhat debatable since both are well streamlined.

11. There are lots of possible advantages to streamlining: speed for escaping enemies or catching food, reduces energy needs in swimming (easier to swim), etc. Reward originality!

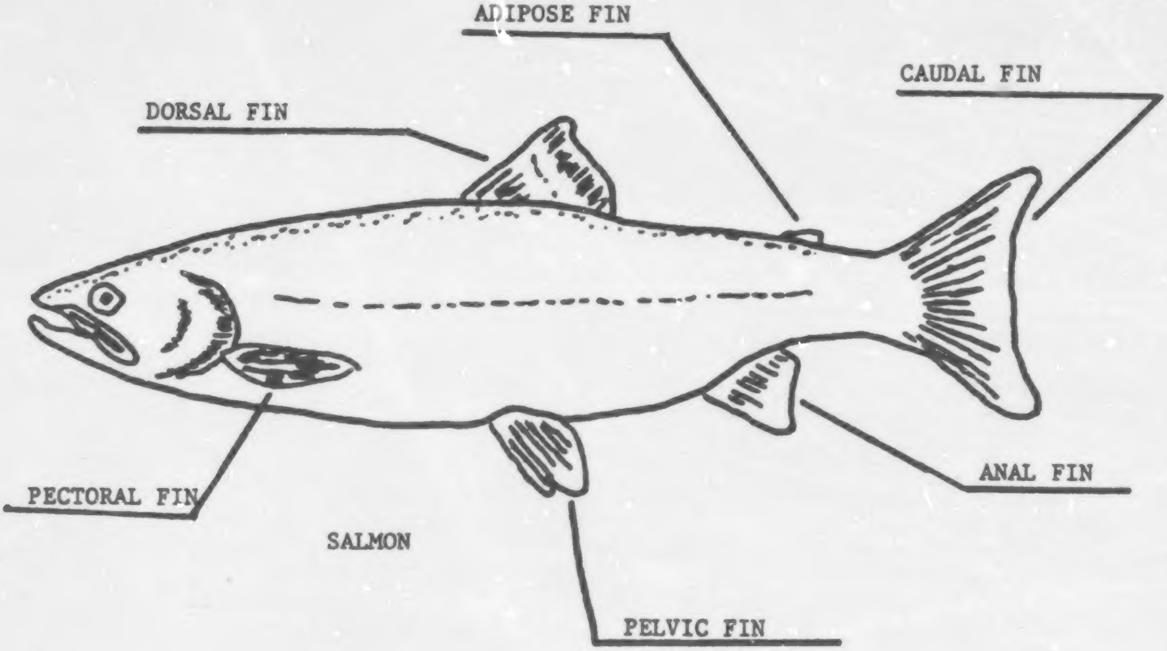
KEY WORDS

adipose fin
anal fin
caudal fin
dorsal fin
ocean pearch
pectoral fins
salmon
spines
streamline
survive
tail fin

FINS

One of the things most people immediately notice about fish is the fins. A swimming fish can hold itself in one place or speed away with a slight flick of the fin. What are these fins and how do they work in helping the fish to survive?

Let's look at a salmon. Some of the fins are paired, others are not. Look at the drawing of the salmon.



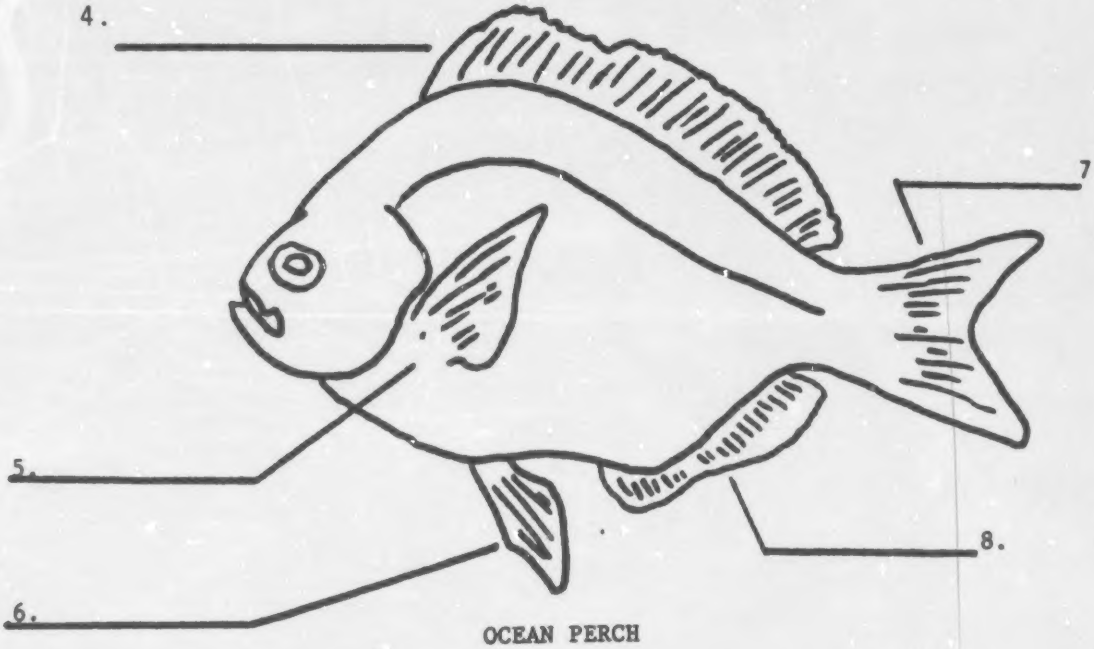
1. How many kinds of fins does the salmon have?__________________

2. Which two kinds of fins are paired? __________________________

3. How many (number) fins does the salmon have? _________________

Each fin has its own job to do. The fish uses the tail fin or caudal fin for steering and power. The pectoral fins on the fish's side are used like an airplane's wings. These fins control the fish's ups and downs. The dorsa, anal and adipose fins are used to keep the fish from rolling over. They also help in steering the fish. In some fish these fins may have spines which aid in protection. The pectoral fins also aid in up and down movement and steering.

Compared to many sea animals fish are very fast. The ability to swim rapidly helps them catch their food and swim from their enemies. Use the drawing and information on the salmon to name the fins on the ocean perch.



OCEAN PERCH

9. Which fin is missing on the ocean perch that is present on the salmon? ____________________

10. Which fish is more streamlined? ____________________

11. Name ways in which streamlining could help a fish survive.

____

____

TEACHER BACKGROUND - Name That Fish

Bottomfish are the unsung heroes of the fish world. They make up the bulk of the finfishes of the world and provide the world with most of its fish protein.

There are billions and billions of commercially important bottomfish in the Bering Sea and the Gulf of Alaska and in other U.S. coastal waters. So far, these stocks of fish have been harvested by foreign fishers. Since 1976 when the U.S. had extended its fisheries management zone 200 miles off our shore, U.S. fishers are getting more interested in what could be a multi-billion dollar year-round industry. But there is a catch to the Fisheries Management Act. We use fish or we lose them.

The law taking over control of all fisheries within 200 miles off our coasts was designed to fill a gap until the nations of the world could agree on a Law of the Sea treaty that would cover the resources of all the oceans. But in the meantime, it gave American fishermen first chance at all the fisheries within the 200 mile zone.

Until that time, except for a few international treaties, high seas fishing was a wide open affair. Fishermen could go after anything they wanted and take as much as they pleased. And the white fish stocks off some U.S. coasts were being harvested so heavily by foreign fleets that some species had dropped to dangerously low levels.

So the main goals of the Fisheries Management and Conservation Act of 1976 were (1) to bring foreign fishing under control and set up management plans to the stocks could build back, and (2) give Americans a reasonable chance to develop the fisheries off their own coasts.

The law did not say that foreign fishermen would have to stay out of the 200 mile zone. But it did say that foreign harvests would be limited to those fish that Americans are unable to catch. In other words, if we don't take them, they will.

Setting up management plans, including quotas for foreign and domestic (U.S.) fishermen, is the tricky task of regional councils, whose actions must be approved by the U.S. Secretary of Commerce. For example, in Alaska, this council is the North Pacific Fisheries Management Council.

Very simply, here is the formula used for setting those quotas:

OY - DAH = FAC.

Translation:

OY stands for Optimum (best) Yield (production). This figure is based on what scientists believe is the largest catch that can be taken, while still keeping stocks at the same level or building back stocks that have fallen. Also considered are social, economic and ecological factors, including food needs.

minus

DAH stands for Domestic (U.S.) Annual Harvest. An estimate of American fishing effort for each species, based on size of boats, amount of gear, price of fish, processing capacity, etc.

equals

FAC stands for Foreign Allowable Catch. This is the total amount left over, which is granted to foreign fishermen (who must get a permit and pay a fee).

"Name That Fish" introduces your students to some of the common "bottomfish". It also introduces your students to the dichotomous key.

Keys are an important tool in the identification of unfamiliar organisms. In this activity your students will have an opportunity to examine a simple key. It is important to emphasize that most keys are restricted to the organisms found in a particular area. Since keys are an artificial construct, different keys can be designed to "key out" the same group of organisms. The most common type of key and the one introduced in this activity is the dichotomous key, a key with two choices at every level. Ideally, the choices are simple "yes" and "no" items ("the item is red" vs. "the item is not red") and the discriminating features are things which can be verified by direct observation ("the item is 1/2 inch or longer in length" vs. "the item is less than 1/2 inch in length"). The alternatives should be quantifiable (1/2 inch or longer rather than "big" or "small"). A good way to introduce the concept of dichotomous keys is to construct a key (in front of the class) to discriminate between the various members of the class. In theory, you could make the key so complete that at the end of each branch you would have one student's name. In practice, this detail is not necessary. It is helpful to key at least one student all the way to the end. The steps might be as follows:

1a Students male (list all male names) go to........2
1b Students not male (list other students' names)...
2a Over six feet tall (list all names) go to........3
2b Six feet or less in height......................
3a Blue eyes.............................Bill Bailey
3b Non-blue eyes...................................

Elicit the discriminants from your class to further increase the interest and participation. In the above example, you would want to emphasize the fact that the only blue eyed male over six feet tall in the class IS Bill Bailey (who, of course, is still not home).

Duplicate the activity pages. One set is recommended per student. You may elect to have students work independently on this assignment, but there is much to be said for working in pairs to build confidence in the use of the key. Plan to devote some time to a discussion of the importance of bottomfish and to provide the correct names for the various fish species.

KEY

Answers to fish identification:

1 - Pacific (true) cod
2 - Alaska (walleye) pollock
3 - sablefish
4 - rattail
5 - smooth lumpsucker
6 - Pacific Ocean perch
7 - lingcod
8 - greenling
9 - skate
10 - yellowfin sole
11 - starry flounder

KEY WORDS

anal fin
barbel
bottomfish
caudal fin
dorsal fin
gill cover
groundfish
lateral line
pectoral fin
speckled

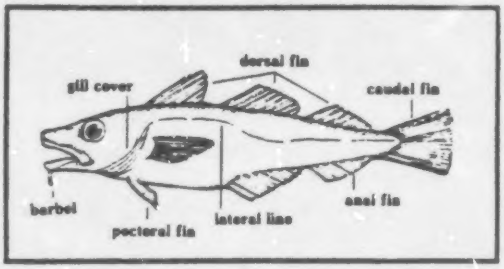
"Name That Fish" is adapted from an article appearing in the February, 1981, issue of "Alaska Tidelines", a University of Alaska Sea Grant Publication.

NAME THAT FISH!

They come in all sizes and shapes and colors. Round, flat, long like eels, fat like a football. Yellow, red, green, speckled. Some with sharp spines on their noses or long pointed tails. Some with wings like a bat. They make up the great bulk of the finfish families of the sea. They are the main food fish of the world.

But what are they? Well, they are often called "bottomfish" or "groundfish". But they really aren't "bottomfish". Only a few spend their lives on the bottom. What they have in common is their tasty white flesh. In Europe, fish like these are favorites on the seafood menu. There they are called "white fish". And that word is beginning to catch on here, too.

Can we get to know these fish a little better? The easiest way to identify fish is with a "key". A key is a kind of yes/no system. Each step of the key is a two-part description. The idea is to compare your fish with the two-part descriptions. The steps describe body shape, number of dorsal fins, etc. Choose the description that fits best. Then follow the directions until you get the answer.



Study the parts of a fish in the drawing above. Then pick out a fish to identify. Start with 1-a and 1-b. Does the fish look round like a salmon? If so, go to 2 and repeat the process. Or does it look flat like a halibut? If this is the case, then repeat the process. When you find its name, write it on the line by the fish. Continue until all are identified.

1. a) Body round ....Go to 2
b) Body flat ....Go to 9

2. a) 3 separate dorsal fins..........................Go to 3
b) Less than 3 dorsal fins.........................Go to 4

3. a) Barbel (whisker) on chin...............Pacific (true) cod
b) No barbel or chin .... Alaska pollock

4. a) 2 dorsal fins...................................Go to 5
b) Less than 2 dorsal fins.........................Go to 6

5. a) 2 separate dorsal fins that look alike...........sablefish
b) Front dorsal fin high and narrow; rear fin long like a pointed tail.......................rattail

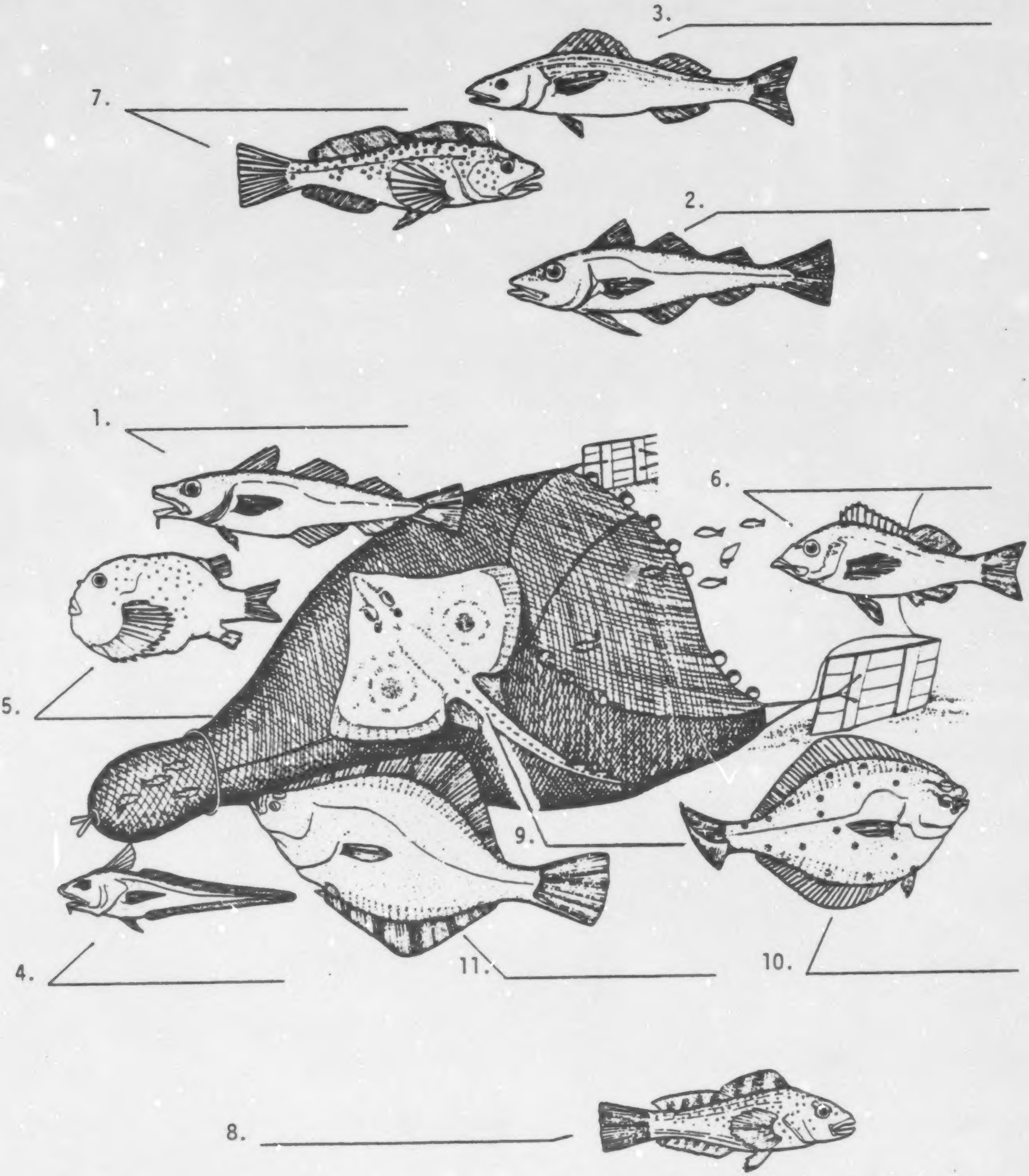
6. a) One small dorsal fin set far to rear ... smooth lumpsucker
b) One long dorsal fin, but different front and back ....Go to 7

7. a) Front part of dorsal fin with sharp spiney spikes; back part smooth ....Pacific Ocean perch
b) One long dorsal fin, notched (like a "V") in the middle ....Go to 8

8. a) One lateral line and large mouth with big sharp teeth................................lingcod
b) Several lateral lines; small teeth...............greenling

9. a) Flat fish with one eye on either side of head; winglike pectoral fins.........................skate
b) Flat fish with both eyes on one side of head......Go to 10

10. a) Eyes on right side of head only............ yellowfin sole
b) Eyes may be on either right or left side of head........................starry flounder


3.
7.
2.
1.
6.
5.
9.
4.
11.
10.
8.

TEACHER BACKGROUND - Healthy Heart Food

For all of our history, seafood has played an important dietary role. There are a number of nutritional qualities about seafood that make it a good alternative to beef, pork and poultry. Seafood is a complete protein. Many nutritionists feel that about 1/3 of the protein eaten daily should come from an animal source in order to balance less complete protein food in cereals and vegetables. An average serving of most seafoods furnishes more than enough complete protein to meet the daily needs of the body.

Seafoods contain a generous amount of such nutrients as calcium, iron, potassium, phosphorus, copper, iodine, magnesium, cobalt and other minerals. Fish products provide adequate amounts of the B family of vitamins and are also good sources of Vitamin A and D. The fat content of seafood is very low when it is cooked by means other than frying. A 3 1/3 oz. serving of finfish has 101 calories; crab, 81; shrimp, 158; pork chops, 198; and beef, 303. The small amount of fat in seafood is unsaturated, low in cholesterol, easily digested and is easily used by the body tissues.

Seafood may be classified into two main categories: finfish (ie. swimming fish like salmon) and shellfish (mollusks and crustaceans). The best way for your children to appreciate seafood is by tasting. Several "student proven" recipes conclude this Teacher Background Section.

KEY

1. Three and one half, or 100 gram, servings are being compared.

2. a. Raw trawlfish has the least cholesterol per 100 gram serving. As an aside, the foods are compared raw because of the variation in substances added in cooking (oil, sauces, spices, etc.).

b. Raw salmon has the second lowest cholesterol content.

c. Low cholesterol diets are probably high in fish. (The correct answer is underlined).

3. a. Cheddar cheese has the most protein per 100 gram serving.

b. Cheddar cheese also has the most fat per 100 gram serving.

c. If one wanted a lot of protein with little fat the foods chosen from the list might include shrimp (note cholesterol), chicken breast, trawlfish, and salmon.

4. a. One hundred grams of cheddar cheese would make the highest calorie snack.

b. Raw trawlfish has the fewest calories.

5. Answers will vary but, in general, nutrionists might think its healthy to get hooked on fish because of its low cholesterol content, high protein content, low fat content, and low calorie content.

KEY WORDS

advertising
calorie
chart
cholesterol
diet
marketing
nutrition
protein

HEALTHY HEART FOOD

"Every forkful of fish and shrimp is loaded with nutrition." People marketing seafood use lines like this in their advertising. The chart below compares fish to other foods. Just how healthy is it to get hooked on fish?

	3½ ounce serving weight (3½ ounces = 100g)	Calories kcal/100g	Cholesterol mg/100g	Protein grams	Fat grams
Trawlfish, raw	100	80	30	19	4
Tiny Pacific shrimp, raw	100	90	95	19	1
Salmon, raw	100	160	40	20	5
Hamburger pattie, raw	100	270	70	18	10
Chicken breast, raw	100	117	90	24	5
Cheddar cheese	100	400	98	25	30
2 Eggs	100	164	500	14	12

Use the chart to answer the following questions:

1. How large of a serving is being compared?

2. Cholesterol is a fat found in many foods. People are concerned about the danger of heart attacks. Because of this many people often eat low cholesterol diets.

a. Which food has the least cholesterol per serving?

b. Which food has the second lowest cholesterol content?

c. Low cholesterol diets are probably high in fish/eggs (circle the correct answer).

3. Protein is needed to build and maintain our bodies. Consider the protein in the foods listed.

  a. Which food has the most protein?

  b. Which food has the most fat?

  c. Many people watch the amount of fats they eat. Which three foods give you high protein and low fat?

    A.
    B.
    C.

4. a. Jogger Jim burns up a lot of calories each day. Which food listed makes the highest calorie snack?

  b. Slender Sam always worries about his weight. Which food listed has the fewest calories?

5. Some doctors recommend eating seafoods seven times a week. Why might they think its healthy to get hooked on fish?

6. Here are some recipes. Help yourself to get hooked on fish.

Shrimp Cheese Dreams

1/2 lb. tiny shrimp
2 (3 oz.) packages softened cream cheese
1/2 cup chopped pecans
1/2 cup drained crushed pineapple
1/4 cup chopped ripe olives
1 tsp. lemon juice
6 slices white bread
6 slices whole wheat bread
softened butter or margarine

Chop shrimp. Combine remaining ingredients except bread. Butter white bread and spread with shrimp mixture. Cover with slices of buttered whole wheat bread. Cut crust from bread. Cut each sandwich diagonally into 4 triangles. Makes 6 servings.

Seafood Bisque

2 cups trawlfish cut into bite-size pieces -OR-
    mixture of trawlfish and tiny shrimp
1/4 cup finely chopped onion
1/4 cup finely chopped celery
2 T. vegetable oil
3 T. flour
1 tsp. instant chicken flavor stock
1/4 tsp. paprika
Dash white pepper
4 cups skim milk
1 cup diced potatoes or frozen hash browns (optional)
Bacon bits
Parsley
Croutons

Saute onion and celery in oil. Stir in flour, instant chicken flavor stock, paprika and white pepper. Add milk gradually. Fold in seafood and potatoes and heat through, about 10 minutes, until potatoes are tender. Serve immediately. Garnish with bacon bits, parsley and croutons. Makes 6 servings.

Fillets a l'Orange

1 lb. fresh trawlfish fillets
2 T. orange juice
1 tsp. lemon juice
1 T. melted butter or margarine
Ground nutmeg
Snipped parsley or dried parsley flakes
Lemon pepper
Orange slices

Arrange fish fillets in glass baking dish, skin (dark) side down. Combine orange juice, lemon juice and melted butter. Pour over fish. Sprinkle nutmeg, parsley and lemon pepper on fish. Bake at 375 degrees F., 15 minutes, until fish flakes easily when tested with fork. Garnish with orange slices. Makes 3-4 servings.

Smokey Fish Spread

1 3/4 cups cooked, flaked trawlfish
1 (8 oz.) package cream cheese
2 T. minced onion
1/4 tsp. salt
1/4 tsp. pepper
1 tsp. prepared horseradish
1-1 1/2 tsp. liquid smoke (if fish is smoked,
use 1/2 tsp.)
3 T. chopped parsley
1 T. lemon juice
Optional:
1/2 cup chopped nut meats
1/4 tsp. garlic powder
2 T. chopped pimento

Drain fish. Whip cream cheese. Add remaining ingredients and mix well. Chill several hours or overnight. Spread on crisp crackers or thin slices of dark rye bread. Makes about 2 1/2 cups.

NOTE: To make a ball, shape after it has chilled. Roll in finely chopped nuts or dried parsley flakes.

TEACHER BACKGROUND - The Dolphin Controversy

"The Dolphin Controversy" highlights the fact that the fishing operations spoken of in earlier activities do not exist in a vacuum. The story of the interactions between dolphins and tuna is an incredible one, bathed in ambiguity, political power plays, and a haze of legalities. The issues have become emotional and hotly debated.

The greatest fear lies in drastically reducing the dolphin populations as the debate continues. Some scientists state that dolphin population danger signs already exist. They note that since estimates on the number of animals killed are based on actual body counts, they can be seriously misleading. Individuals that have been injured and escaped only to die a short distance away are not counted. Also, no one knows what the killing is doing to herd structures. Dolphin herds on the fishing grounds are showing a 50-50 ratio of juveniles to adults. In the unexploited populations, the ratio favors the adults by a margin of 85-15. The exploited population ration mimics that seen in other dolphin populations prior to rapid declines.

For additional, current information consider contacting the following groups:

American Tuna Boat Association
One Tuna Lane
San Diego, California

Animal Protection Institute of America
P.O. Box 22505
Sacramento, California 95822

Duplicate the text pages. One set is recommended per student. This activity may be completed by individual students as an in-class or homework assignment. Supplement the activity with pictures of marine mammals. Plan to devote some time to a discussion of the reading and to provide the correct answers for the text questions.

KEY

1. Yellowfin tuna are often found swimming beneath groups of dolphins.

2. Dolphins surface so frequently because they are air-breathing mammals.

3. Answers will vary, the question calls for a speculation on the part of your students so any answer must be considered a possiblity. The most common answers will be: the tuna swam away; and, the tuna are under the dolphins.

4. The tuna/dolphins need to come to the surface to breathe (The correct answer is underlined).

5. It is in the tuna fishers' best interest to release the dolphins so that they may be used in the future to locate groups of yellowfin tuna.

6. This question again calls for an opinion.

7. A boycott could reduce fishers' income. The reduced income would, in theory, cause the fishers' to reconsider their tactics.

KEY WORDS

boycott
conservationists
controversy
deployed
float line
lead line
mammals
panic
relationship
sacrificed
seine skiff
ultimate
yellowfin tuna

ADDITIONAL RESOURCES

The introduction of marine mammals into the curriculum may raise much interest and a lot of questions. The following is a list of organizations and publications which can help you expand the topic to any degree desired.

American Cetacean Society
"The Whalewatcher"
P.O. Box 4416
San Pedro, CA 90731

Defenders of Wildlife
"There's A Sound in the Sea"
A filmscript and teacher's resource
unit on whales
1244 Nineteenth Street N.W.
Washington, D.C. 20036

Earth Art Works
% Steve King
P.O. Box S
Alameda, CA 94501
phone (415) 769-8500

General Whale
% Larry Foster
P.O. Box Save the Whale
Alameda, CA 94501
phone (415) 865-5550

Greenpeace Foundation
Good Shepherd Center
4649 Sunnyside Avenue N.
Seattle, WA 98103
(206) 632-4326

Colored Whale Chart
"Marine Mammals of the
Western Hemisphere"
Superintendent of Documents
U.S. Government Printing
Washington, D.C. 20402

Stock No. 003-020-00106-8
U.S. Gov't Printing
1975, 653-059

Whale Museum
P.O. Box 1154
Friday Harbor, WA 98250

WHALE BOOKS, Children

Beaty, John Y. The Baby Whale Sharp Ears. (J.P. Lippincott Co., 1938). Exciting story of the adventures of a baby sperm whale.

Cook, Joseph J. and Wisner, William. Blue Whale, Vanishing Leviathan. (Dodd, Mead and Co., 1973). Blue whale's habits, anatomy and overhunting that led to its near extinction.

Griggs, Tamar. There's A Sound In the Sea. $5.95 paper. (Scrimshaw Press, 1975). A child's view of the whale through drawings and poems.

Grosvenor, Donna. The Blue Whale. (National Geographic Society, 1977). Story of a baby blue whale. Excellent illustrations by Larry Foster.

Hurd, Edith Thacher. The Mother Whale. (Little Brown and Co., 1973). The birth of a baby whale.

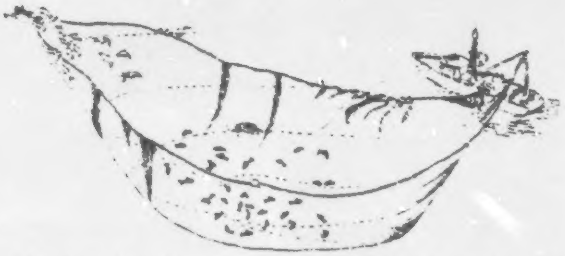
Scheffer, Victor. Little Calf. $5.95 hard. (Charles Scribner's Sons, 1970). Adapted and shortened version of "Year of the Whale".

Steig, William. Amos and Boris. (Farrar, Straus and Giroux, 1971). A moving story about a whale and a mouse.

Stonehouse, Bernard. A Closer Look at Whales and Dolphins. (Glouster Press, 1978). Biology of whales for teachers and children. Good resource.

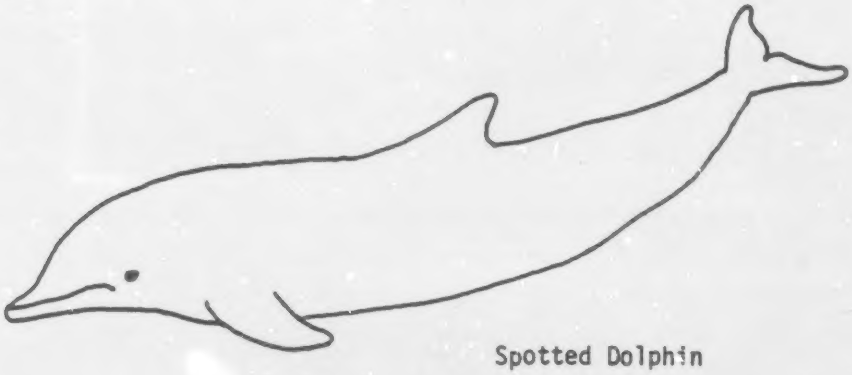
Young, Jim. The Whale Came to My Home Town. $3.95 hard. (Alfred Knopf, 1974). True story of a stranded whale from a child's point of view, simply written, excellent photos.

Zim, Herbert. The Great Whales. (William Morrow and Co., 1951). Facts about whales.



THE DOLPHIN CONTROVERSY

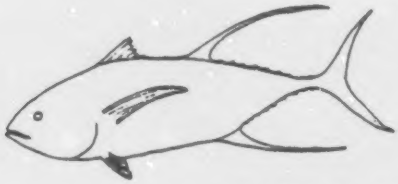
Why would anyone get upset about a tuna sandwich? Yellowfin tuna live in warm Pacific Ocean waters. These tuna often swim beneath groups of dolphins. No one knows why this is so. Fishers have known this for years. About 1970, the tuna/dophin controversy began.



Spotted Dolphin

1. Where are yellowfin tuna often found?

What happened in 1970? The American tuna industry developed a new fishing method. The method focuses on the mysterious relationship between dolphins and tuna. The method is called "fishing on porpoise". (These dolphins are often called porpoises.)



Yellowfin Tuna

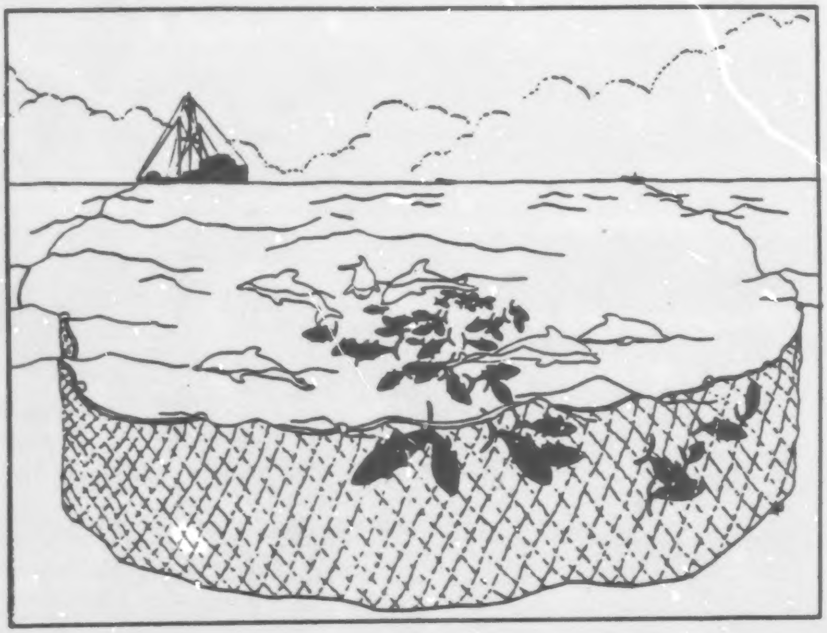
Dolphins are mammals. Like you, they breathe air with lungs. They must come to the surface often to breathe. Their surfacing and jumping makes the dolphins easy to spot.

?. Why do dolphins surface so frequently?

Tuna fishers aboard the Joan P. spot a group of dolphins. Electronic gear show that tuna are with the dolphins. Speed boats are quickly lowered into the water. The motor noise panics the dolphins. They try to swim away. The speed boats "round up" the dolphins.

3. Where do you think the tuna have gone?

For unknown reasons, the tuna stay close to the dolphins. A seine skiff moves away from the Joan P. It is towing one end of a long net. The net is towed around the dolphins and tuna. The net may be a mile long. It can be 250 feet deep.

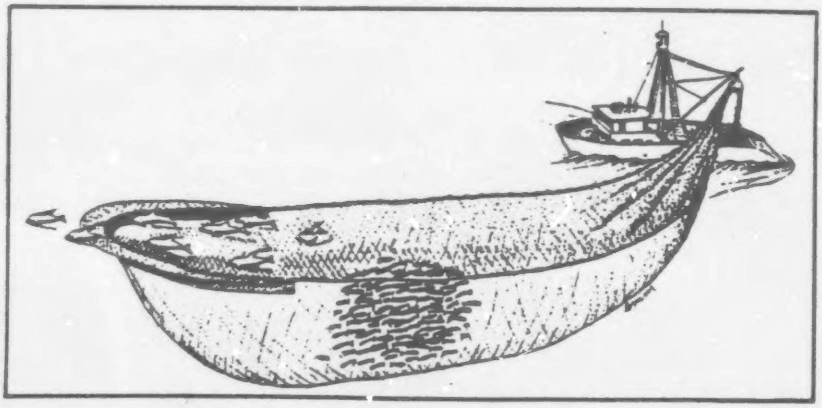


The two boats work together to complete the circle. The top of the net is kept in place by the float line. The bottom is held down by the lead line. The purse line is pulled in. It closes the bottom of the net. The tuna and the dolphins are caught.

4. The tuna/dolphins need to come to the surface to breathe.(Please circle the correct answer).

Most of the net is quickly pulled aboard. A small section is left in the water. The section contains the tuna and dolphins. The tuna move to a deep pocket of water. The pocket is near the side of the ship. The dolphins stay near the edge of the net. This is the critical stage for survival of the dolphins.

The skipper of Joan P. begins to "back down". The ship pulls the net out from under the dolphins. Most of the dolpnins swim away.



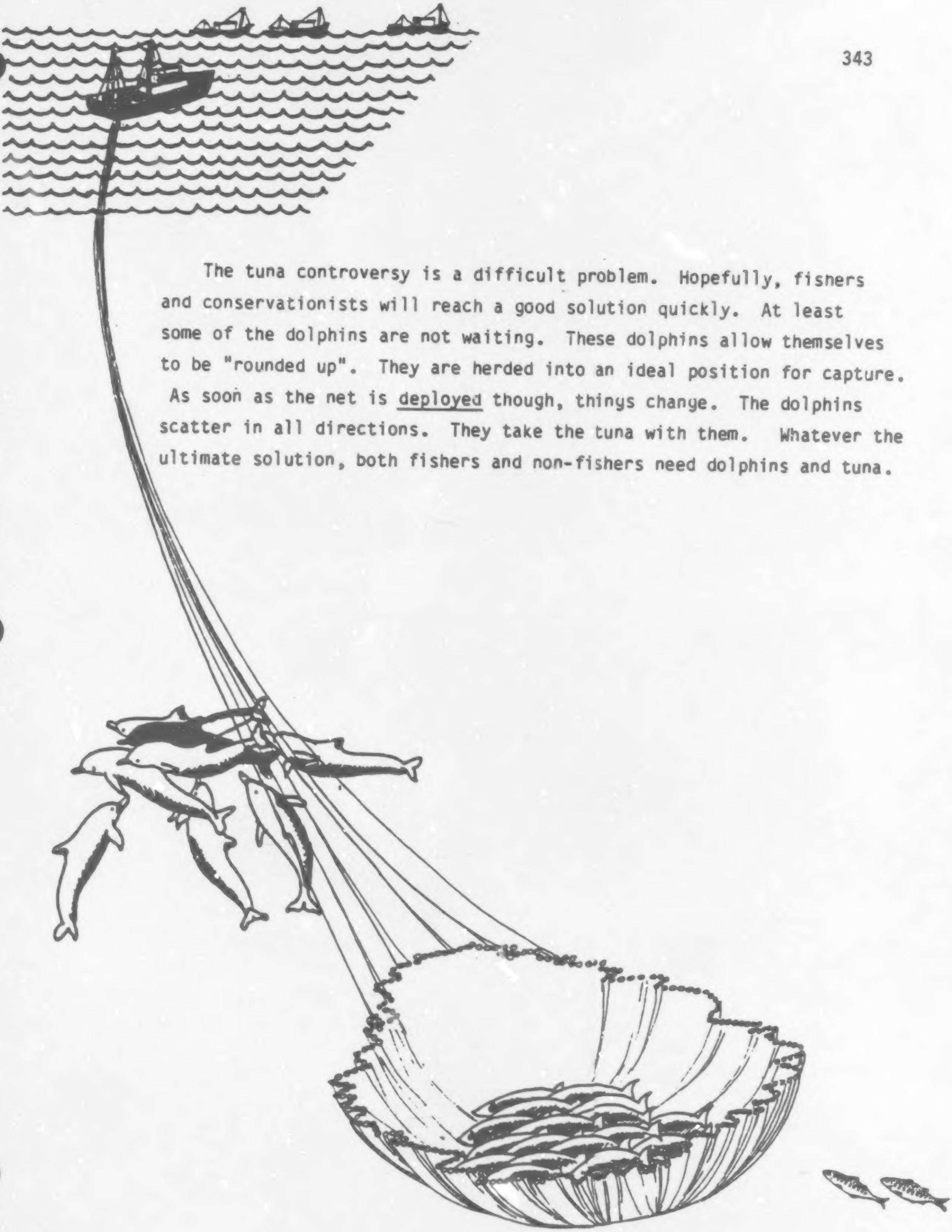
5. Why is it in the tuna fishers' best interest to release the dolphins?

The rest of the net is hauled aboard. The tuna and any remaining dolphins are caught. At any point dolphins may be killed or injured. The controversy centers over how many can be sacrificed.

6. How many dolphins do you think could be reasonably sacrificed?

Some conservationists say sacrifice zero dolphins. They think no dolphins can be reasonably sacrificed. The Japanese government classes dolphins as "harmful marine mammals". Their tuna fishers treat the dolphins as such. The U.S. government passed laws limiting the dolphin kill. The tuna fishers threatened to leave the country. In some other place, they could fish as they please. New techniques are being developed. For now, 100,000 dophins each year are killed by American tuna fishers.

7. One group of conservationists urged a boycott of yellowfin tuna. Yellowfin tuna is sold as "light meat" tuna. Albacore, skipjack or bonita are caught on hooks. The boycott tried to get tuna fishers to change. People hoped this would cause people not to buy yellowfin tuna. How might a boycott make fishers change?



The tuna controversy is a difficult problem. Hopefully, fishers and conservationists will reach a good solution quickly. At least some of the dolphins are not waiting. These dolphins allow themselves to be "rounded up". They are herded into an ideal position for capture. As soon as the net is deployed though, things change. The dolphins scatter in all directions. They take the tuna with them. Whatever the ultimate solution, both fishers and non-fishers need dolphins and tuna.

Read the statements below. Fill in the correct word from the word list. Notice that after each word, there is a series of letters and a number. Use these series to connect the correct dots. Not every dot is used. The letters are not used in order. If you're correct, a drawing will appear. Good luck.

1. ______________________ tuna are often found with dolphins.

2. Dolphins breathe air with __________________ .

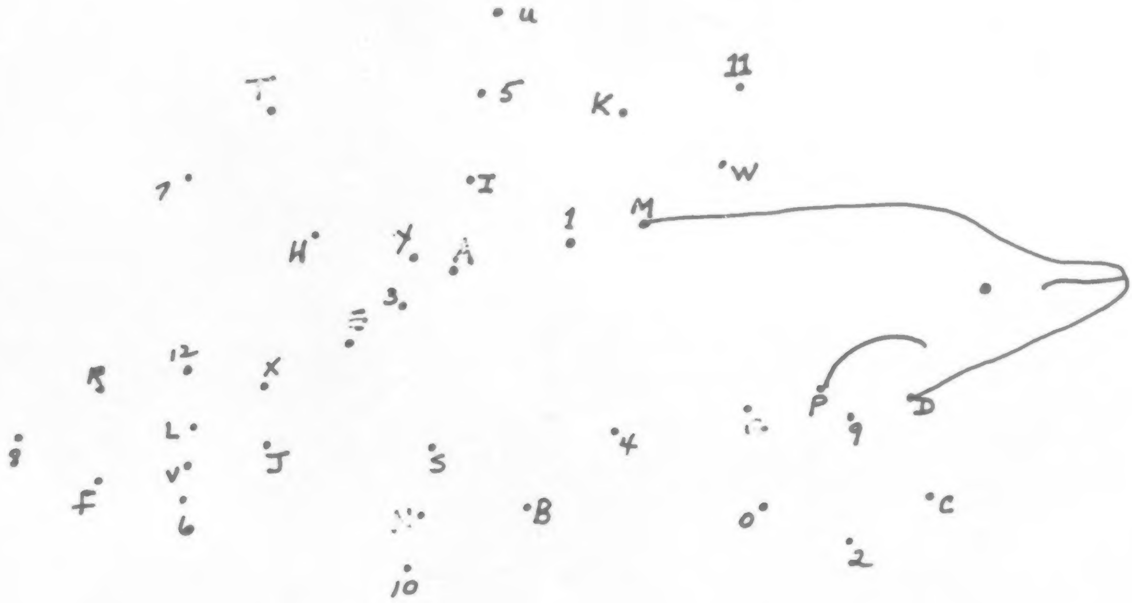
3. The top of the tuna seine net is the ___________________.

4. Pulling the net out from under the dolphins is called

__________________________.

5. A tuna ________________ would see people stop buying tuna.

6. The tuna __________________ is a difficult problem.



WORD LIST

ALBACORE	(C-2-O)	CORK LINE	(J-6-V)	PROBLEM	(K-11-W)
BACK DOWN	(L-12-X)	GILLS	(I-5-U)	REVOLT	(F-8-R)
BOYCOTT	(E-3-Y)	LEAD LINE	(H-7-T)	SLIP BACK	(B-10-N)
CONTROVERSY	(A-1-M)	LUNGS	(G-4-S)	YELLOWFIN	(D-9-P)

TEACHER BACKGROUND - The Seeing Ear

Cetaceans, whales and dolphins, sense their surroundings and communicate with each other through sounds. Echolocation is akin to seeing with your ears. Sound is the primary sense in the life of Cetaceans. Many whales and dolphins navigate and hunt at night or below the zone of illuminated water. Whereas vision depends on the presence of light, sounds can be made and used at any time of the day or night, and at all depths. Sounds can be infinitely varied - high to low, loud to soft, and so on. The sounds can be pinpointed by maker and by listener. As noted, cetacean sounds are used for two purposes: communication and echolocation. "The Seeing Ear" is an activity dealing with this latter purpose.

"The Seeing Ear" introduces students to echolocation through a tie-in with the tuna/dolphin controversy discussed earlier. You may elect to do the background reading and questions as a separate assignment prior to the activities. Duplicate the text and activity pages. Although students will be working in pairs, one set of pages is recommended per student. Prepare your students by emphasizing the need for a quiet classroom environment so that they may "see" with their ears. While you may elect to have pairs of students do the activities as demonstrations before the class, much is to be gained by having the entire class perform them. Whichever approach you elect to use, plan to devote some time to a discussion of the questions and activities.

KEY - Text Questions

1. Two reasons why sound might be superior to sight for dolphins include the fact that dolphins hunt at night and below the lighted zone of the ocean. Both of these conditions render sight of limited value.

2. Answers will vary. This question is designed to get your students to read critically and use their word attach skills on unknown vocabulary.

3. Three observations lead to scientific study of dolphin echolocation. They are:

   a. The dolphins *never*/sometimes swam into small mesh nets. (The correct answer is underlined).

   b. The dolphins *would*/would not jump over the nets in the dark. (The correct answer is underlined).

   c. The dolphins never/*sometimes* swam into large mesh nets. (The correct answer is underlined).

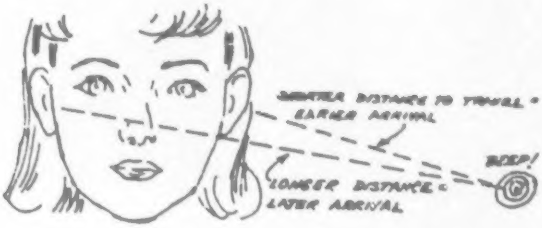
4. Dolphins can judge *location*, *speed* and *direction* of an object by listening to the echoes from the object.

5. The diver's lungs must have a density *about the same as* water. (The correct answer is underlined)

I. Direction - Analysis/Interpretation

1.-2. Answers will vary depending upon experimental results. In general, the dolpins will be more successful using two ears and most successful using two ears with the added option of moving her head. The reasons for this are explained in the introduction to student question 3.

3.


SHORTER DISTANCE TO TRAVEL = EARLIER ARRIVAL
BEEP!
LONGER DISTANCE = LATER ARRIVAL

II. Size - Analysis/Interpretation

1. a.-b. Answers will vary depending upon experimental results. In general, your students will be only as successful as they are lucky. In other words, few will be able to discriminate between the two circles by using their eyesight.

2. Most students will agree that their eyesight is less acute than the dolphins' "earsight".

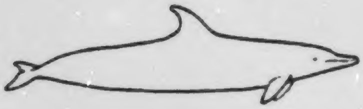
Summary

1. People with hearing in only one ear have, among other difficulties, problems in locating the direction of sounds and of people and objects making those sounds. These indivduals can compensate for some of their hearing loss by moving their heads around.

2. She should turn to her left and backwards. When she hears the echoes arriving at both sides at the same time, and coming closer together, she is heading right for the fish.

KEY WORDS

computes
density
cork line
echo
echolocation
interpret
lead line
mesh
murky
navigation
observations
vision



THE SEEING EAR

"But can't the dolphins see the nets?" Couldn't dolphins avoid tuna nets if they saw them? Let's take a look at dolphins.

Amazing but dolphins "see" with their ears. What's the benefit of this? Vision is difficult in the dark, murky seas. Dolphins may hunt at night. They may hunt below the lighted zone of the ocean. Vision depends on light. But sounds can be made at night or in deep water. Dolphin brains store sound pictures. The sounds come from echoes the dolphins make.

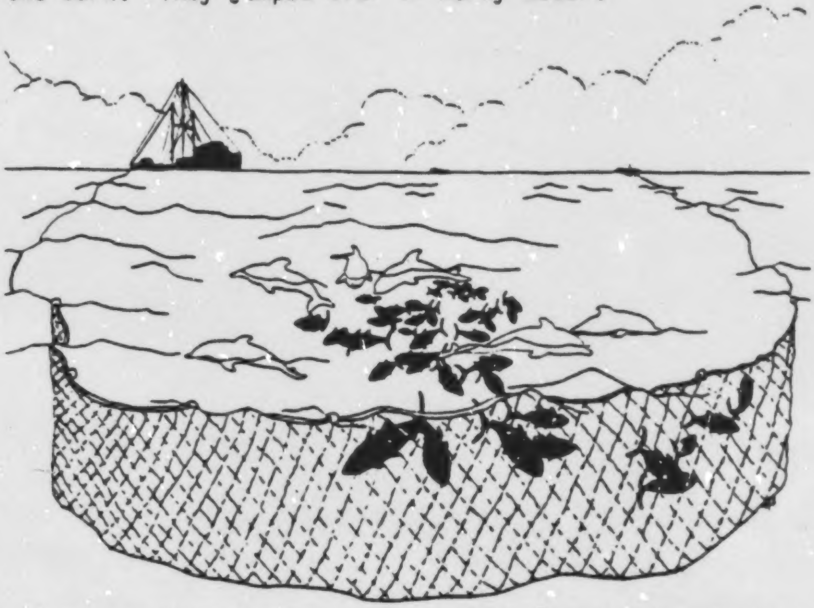
1. What are two reasons sound might be superior to sight for dolphins?

Most dolphins have two kinds of voices. One voice is used to "talk" to each other. The other voice is used for navigation. This second voice is also used for echolocation.

2. Navigation refers to finding out where you are. It also refers to finding out where you're going. What do you think echolocation refers to?

Echolocation means sensing the location of objects using sound. The dolphins interpret the echoes. Whalers and fishers had long suspected that dolphins had a special way of "seeing". Scientists began to study into the matter after several interesting observations.

A fisher in Florida made the first observation. He was using a net to catch small fish. He noticed that dolphins never swam into the net. The net had a small mesh. The dolphins jumped over the corkline. They jumped over in the dark. They jumped over in murky water.

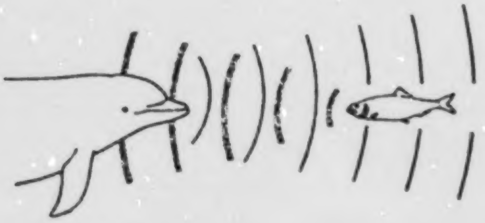


The fisher noticed one more thing. If a large mesh net was used, the dolphins ran into the net. After dolphins became entangled in the net, the corkline would sink. At this point the other dolphins would leap over.

3. Three observations lead to scientific study of dolphin echolocation. They were:

   a. The dolphins never/sometimes swam into small mesh nets. (Please circle the correct answer)
   b. The dolphins would/would not jump over the nets in the dark. (Please circle the correct answer)
   c. The dolphins never/sometimes swam into large mesh nets. (Please circle the correct answer)

Dolphins make a series of clicks to echolocate. The clicks move through the water as sound waves. When the clicks strike an object, they bounce back. The dolphin senses the echoes. From the echo, the dolphin can judge location, speed, and direction of the object.



4. What can dolphins tell about an object by listening to the echoes?

a.
b.
c.

People sometimes swim with dolphins. What does a dolphin "see"? The dolphin can "see" inside the diver. It can "see" the diver's lungs and other organs. How can this be? Human flesh has about the same density as water. The echoes pass through objects with the density of water. The dolphin can easily tell objects with different densities apart. So to the dolphin, the diver might look like an x-ray photograph of the human body.

5. The dolphin can "see" the diver's lungs. The lungs must have a density about the same as/different than water. (Please circle the correct answer)

Do the following activities to test your ability to echolocate.

I. Direction

1. For this activity you'll need to work in pairs. One person is the dolphin. The second person is the fish 'target'.

2. Have the dolphin close her eyes. (You may need a blindfold!) The fish 'target' will choose three (3) locations in the room to hide.

3. At location one, the fish snaps his fingers. (He may clap his hands.) The dolphin KEEPS HER EYES CLOSED AND HEAD STILL! She listens to the sound. The dolphin then points to the direction from which the sound is coming. RECORD whether the dolphin was correct on your data sheet.

4. Repeat step 3 for two additional locations.

5. Now have the dolphin cover one ear. Repeat steps 2, 3 and 4. (The fish will want to choose new locations!)

6. Very few animals keep their heads still all the time. Try your skill at finding the fish by moving your head. Do this for three locations with both ears uncovered. RECORD your data on the chart.

7. Repeat step 6 with one ear covered.

8. If you have time, change roles and repeat the activity.

Analysis and Interpretation

1. a. Was the dolphin always successful in locating the fish?
   b. If not, was she more successful using one ear or two?

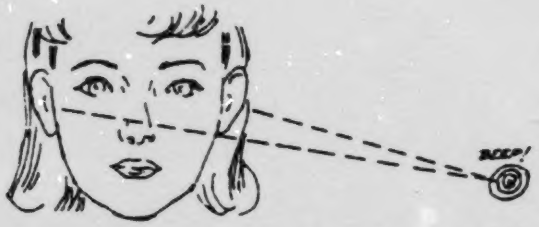
2. a. Was the dolphin more successful when she could move her head?
   b. If so, was she more successful with one ear or two?

3. Sound sources usually are closer to one ear. Because of this, the sounds arrive at the ears at different times. Our brain computes the difference in messages from the ears. This information tells us something about direction.

Use the drawing below to answer these questions:

A. Circle the sound wave with the shortest distance to travel.

B. Put an X on the sound wave with the longest distance to travel.



II. Size

Materials:
circle sheet
scissors

1. A dolphin's sense of echolocation is so accurate they can tell the difference between a ball 2 1/2 inches across and one 2 1/4 inches across. Obtain a circle sheet.

2. Cut out two circles. The larger circle is 2 1/2 inches across. The smaller is 2 1/4 inches across.

3. Work in pairs. Select one member of the pair to hold the circles. The other member should walk 35 paces and turn around.

4. The person holding the circles asks "which is larger?". Without telling if the answer is correct, record the answer.

5. Shuffle the two circles and repeat step 4, three more times.

6. If you have time, change roles and repeat the activity.

Analysis and Interpretation

1. a. How many times was partner one able to correctly identify the larger circle? ______

b. How many times was partner two able to correctly identify the larger circle? _______

2. Dolphins easily distinquish the two sizes at a greater distance. How does your eye sight compare with dolphin "ear sight"?

SUMMARY

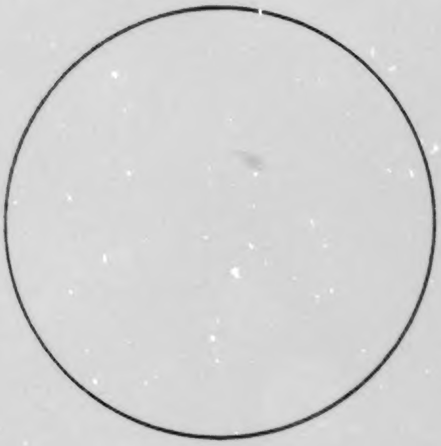
1. Some people have hearing in only one ear. What kind of problems might they face?

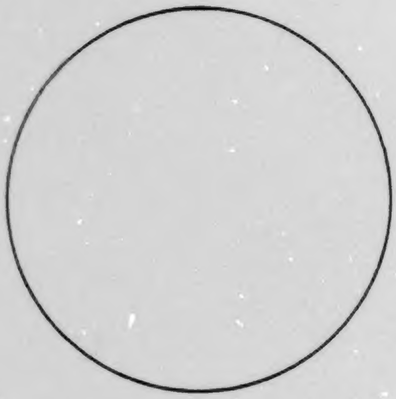
2. A spinner dolphin is swimming straight ahead. She is hungry. She sends out a series of clicks. She senses echoes from a tasty fish. The echoes arrive on her left side earlier than on her right. She continues swimming. The echoes arrive later and later.

Which way should she turn to catch the fish?

Circle Sheet

Can you tell these apart with your eyes as well as a dolphin can with its ears?





TEACHER BACKGROUND - Food From the Sea

This activity deals with the concepts of food chain and food web. A food chain is a linear relationship that shows who eats whom or more importantly, where the energy goes in the system. A food web is made up of many interlocking food chains. Phytoplankton serve as the basis for most ocean food chains. In other words, most life in the ocean directly or indirectly depends upon these microscopic plants. It has been estimated that about two thirds of the oxygen produced by plants is produced by phytoplankton. As such, we can say that life on land is also dependent upon the work of the phytoplankton!

Please read the activity beforehand and understand the answers to the questions. A more complete discussion of food webs and food chains may be found in most introductory biology or ecology texts.

FOOD FROM THE SEA- TEACHER KEY

PART I

1. If fisherman A caught a shrimp for dinner, he would be a third order consumer. He is eating a second order consumer, the shrimp.
2. If fisherman B caught a herring for dinner, he would be a fourth order consumer. He is eating a third order consumer, the herring.
3. If fisherman C caught a salmon for dinner, he would be a fifth order consumer. He is eating a fourth order consumer, the salmon.
4. To get the most of the original sun energy we should eat phytoplankton.
5. This is an open ended question. The first problem is to collect a sufficient amount of phytoplankton. Then you might have plankton-burgers, plankto-shakes, etc. The idea of changing cultural eating patterns should be discussed.

6. Many food chains are possible, both land based ones and aquatic ones. For example:

grass → cow → man
algae → shrimp → fish → man

The number of links in the chain can vary, but it needs at least three.

Part II

1. The primary producer gets its food from the sun and nutrients in the water. This question is designed to make your students refer back to Part I and recognize that they'll need to do so periodically.

2. The first order consumer is the zooplankton. The zooplankton eats the phytoplankton which is the primary producer.

3. Man could reasonably eat the shrimp, herring, and salmon. The highest level consumer where we could place man would, therefore be fifth order consumer.

5. If a virus kills all of the shrimp, we would have two short chains left. No, both parts of the chain would not be able to survive. The part of the chain with the phytoplankton and zooplankton would be able to survive. With no food, the part of the chain with herring, salmon, and man would not survive.

6. e. If the sun disappeared, all of the organisms in the chain would also disappear, although at varying rates with the phytoplankton going first.

7. b. "MAN" links make sense at the links for herring and shrimp as well as for the salmon link.

8. You may need to provide some initial help with animal names. Once your students get started, they should be able to easily continue.

9. The number of links will vary. Removing one link from a food chain is usually more destructive than removing one link from a food web.

Parts of "Food From the Sea" is adapted from an activity prepared for Makahiki Kai '77 by the Sea Grant College Program of the University of Hawaii (publication UNIHI - SEAGRANT - MR-77-01).

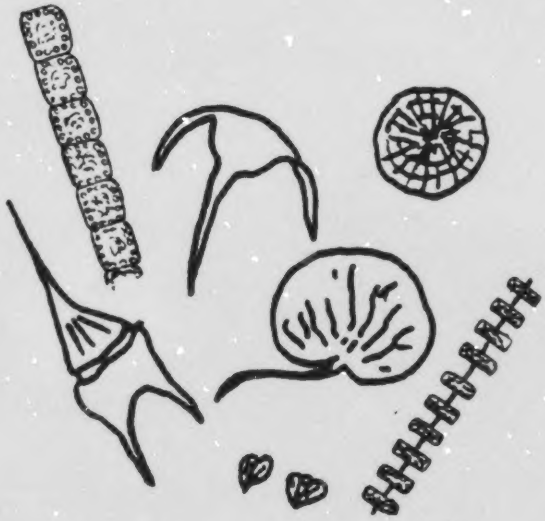
KEY WORDS - Food From the Sea

animals
complicated
consumer
destructive
drift
first order consumer
fisherman
food chain
food pyramid
food web
fourth order consumer
herring
knowledge
link
microscopic
nutrients
organisms
phytoplankter
phytoplankton
primary producer
relationships
salmon
second order consumer
shrimp
strips
sunlight
zooplankter
zooplankton

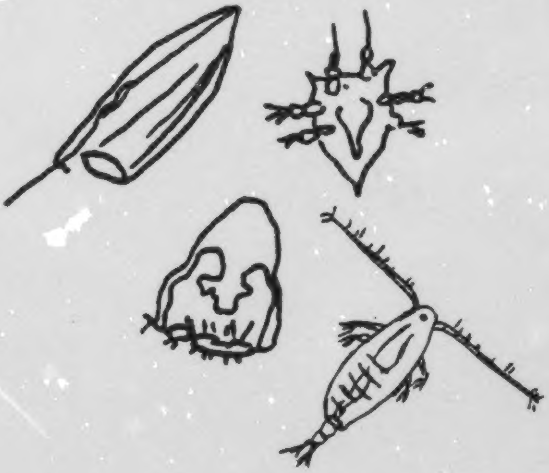
FOOD FROM THE SEA

PART I

The sea is full of things to eat. Not all of the food, however, is food for man. Let's take a look at some of the food in the sea. PHYTOPLANKTON (one is called a phytoplankter) are microscopic marine plants. They make food from the nutrients in the water and sunlight. ZOOPLANKTON are microscopic animals that drift in the ocean. Like phytoplankton, zooplankton are too small for us to eat. There are many kinds of free swimming FISH that live in the oceans. Some of these we eat, but not all of them.

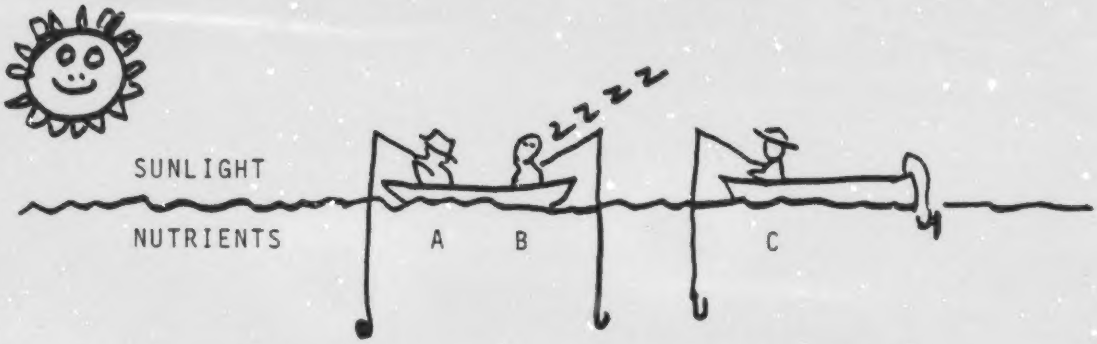


PHYTOPLANKTON



ZOOPLANKTON

Let's imagine you were a tiny phytoplankter. You'd get your food from the sum and nutrients in the water. You'd be called a PRIMARY PRODUCER. This is because you do not eat any other living things. Along comes a zooplankter. He gobbles you up! The zooplankter is the FIRST ORDER CONSUMER. He's the first to eat you. There's a shrimp swimming by. It eats the zooplankter. The shrimp is a SECOND ORDER CONSUMER. A herring eats the shrimp. A salmon eats the herring. You, the tiny phytoplankter, end up feeding a salmon. Amazing!


SUNLIGHT
NUTRIENTS
ZZZZ
A
B
C

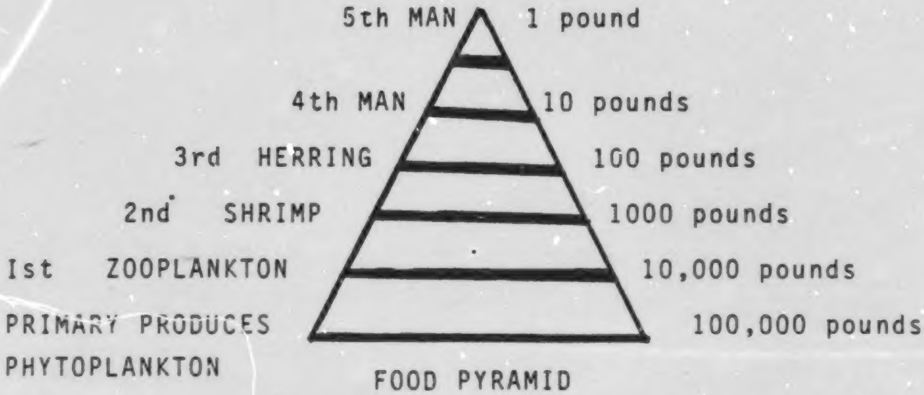
PHYTOPLANKTON ⟶ ZOOPLANKTON ⟶ SHRIMP ⟶ HERRING ⟶ SALMON

PHYTOPLANKTON	ZOOPLANKTON	SHRIMP	HERRING	SALMON
Primary Producer	1st Order Consumer	2nd Order Consumer	3rd Order Consumer	4th Order Consumer

Now let's think about man. Where does he fit? He can eat the shrimp, herring, or the salmon. Man can fit in several places in this food series.

1. Fisherman A caught shrimp for dinner. What order consumer is fisherman A? ______________________
2. Fisherman B caught a herring for dinner. What order consumer is fisherman B? ______________________
3. Fisherman C caught a salmon for dinner. What order consumer is fisherman C? ______________________

We call this series of "eating" a FOOD CHAIN. Of course, a zooplankton eats more than one phytoplankton. How much food each animal needs to eat can be shown in a FOOD PYRAMID.


5th MAN
1 pound
4th MAN
10 pounds
3rd HERRING
100 pounds
2nd SHRIMP
1000 pounds
Ist ZOOPLANKTON
10,000 pounds
PRIMARY PRODUCES PHYTOPLANKTON
100,000 pounds

FOOD PYRAMID

Energy is lost at each step of the pyramid. It takes 100,000 pounds of phytoplankton to feed 10,000 pounds of zooplankton. Ten thousand pounds of zooplankton can feed 1,000 pounds of shrimp. These 1,000 pounds of shrimp can feed 100 pounds of herring. The 100 pounds of herring can feed a 10 pound salmon. Ten pounds of salmon would feed only one pound of a man. One man may weigh 185 pounds! Man can get more of the original sun energy. He would get more by eating herring instead of salmon.

4. What should man eat to get the most of the original sun energy?

____

More people require more food. We get more food energy by eating farther down on the pyramid.

5. How could we eat plankton?____________________________

____

____

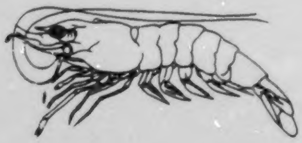
Shrimp, herring and salmon aren't the only animals in the ocean. Think about all the animals. Think about what they eat. These eatings make a complicated picture. We call this picture a FOOD WEB. A food web shows these feeding relationships.

6. What do other animals eat? Use your knowledge of other animals and plants. Make a FOOD CHAIN in the space below.

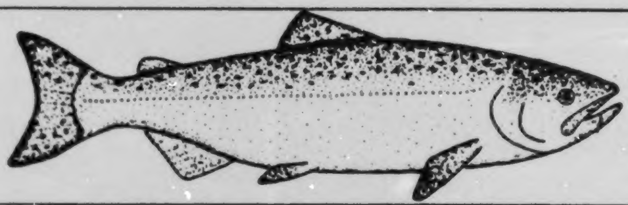
PART II

Food chains are sometimes hard to picture. Let's use the strip drawings below to make our own food chain.

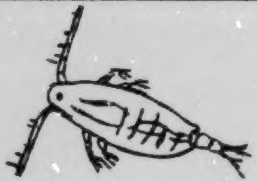
○ SHRIMP ○



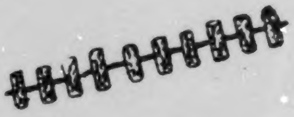
○ SALMON ○



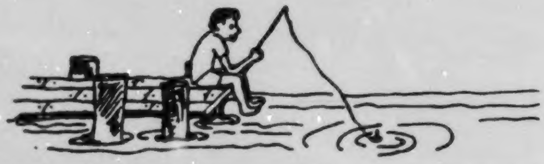
○ ZOOPLANKTON ○



○ PHYTOPLANKTON ○



○ PERSON FISHING ○



○ ○

○ ○

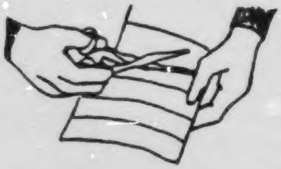
1. Color the primary producer green. Where does the primary producer get its food?

2. Which animal is the first order consumer? ______________ What does it eat?

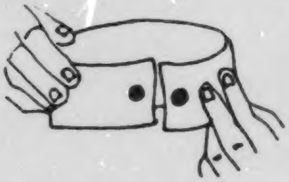
3. Which of these animals and plants could be eaten by man?

4. a. Obtain a pair of scissors and a stapler or paste.

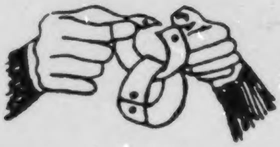
   b. Cut out the strips on the solid lines.



   c. Find the strip that shows the primary producer. Match the dots on it to make one link. Staple or paste the link at the dots.



d. Now add the link showing the animal that would eat the primary producer.



e. Keep adding links. Stop when you have a chain with five links. Be sure your links are in the correct order.

5. Now you have a single chain. Imagine that a virus kills all of the shrimp. How many chains would you have left? ________ Would both parts of the chain be able to survive? __________ If not, which organisms (plants and animals) would be able to survive? List them here:

6. a. Obtain a strip the same size as your other links.

b. Draw the sun on the strip.

c. Write the word "SUN" on the strip.

d. Add the sun strip to your chain in the correct place.

e. What would happen to your chain if the sun disappeared?

7. a. People can eat several of the animals shown on our links. Obtain several blank strips.

   b. Write "MAN" on the strips.

   c. Add your new "MAN" links where ever they make sense.

8. a. Adding the "Man" changes your food chain into a food web. Obtain several more blank strips.

   b. Look at your links. Think about who might eat some of the organisms. Write the names of these new animals on your blank strips.

   c. Add the new strips to your food web.

9. How many links are in your food web? ________ Removing one link from a food chain is usually more destructive/less destructive (circle the correct answer)than removing one link from a food web.

10. Put your name on your food web. Display it proudly!

TEACHER BACKGROUND - Gyotaku - Japanese Fish Printing

Fish printing is a fun activity and can provide a hands on opportunity to learn about fish anatomy. During this exercise be sure to take advantage of the opportunity to tie in the activity "Fins."

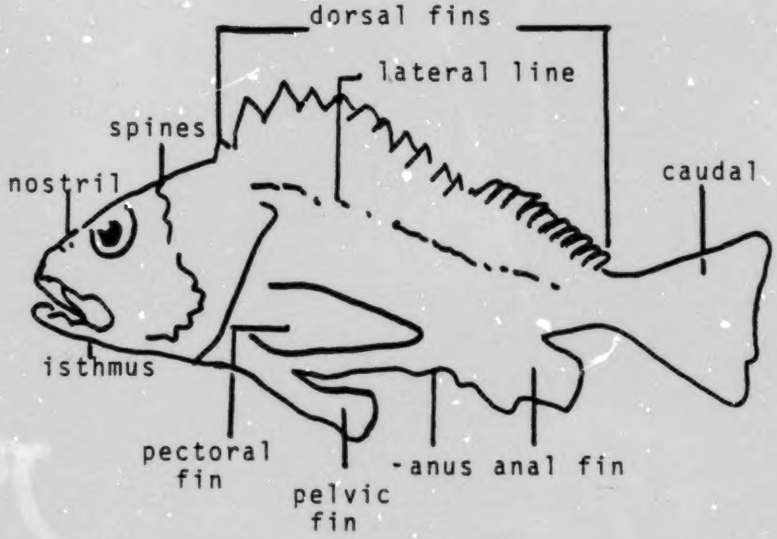
Since this can be a somewhat messy activity, be sure to cover desk tops with newspaper and provide paper towels for hands. Thick water-based inks are best for beginning. Water-based linoleum block printing ink is another excellent ink, and it's easy to use. Again, black is a good color to work with, but you may want to try such other dark colors as brown, red, green, or blue.

A good source of further inofrmation on Japanese Fish Printing is Leaflet 2548 "Gyotaku - Japanese Fish Printing" from California Sea Grant. The publication is available free of charge from: Christopher M. DeWees, Extension Marine Resources Specialist, University of California, Davis, California.

To help guarantee good printing results it is useful to understand fish anatomy. The short lesson on fish anatomy that follows is from Leaflet 2548.

FISH ANATOMY

Here is a rough sketch of external fish anatomy.



1. Fins: Most fish have a least one dorsal fin, a caudal fin, an anal fin, a pair of pelvic fins, and a pair of pectoral fins. Often the first dorsal fin will have hard, sharp spines, while the other fins will have soft, flexible fin rays. The fin spines and rays are connected by a thin fleshy material that readily collects excess mucus and ink that should be wiped off. Some fish (trout and salmon) have a small fleshy adipose fin

2. Scales: Fish scales vary in structure and reproduction quality. Sharks have sandpaper-like scales that are really modified teeth; they are difficult to print and require an extra thick coating of ink. Trout, salmon, and smelt have delicate "deciduous" scales that are difficult to print; sometimes removing all scales and printing the scale pocket that the scale lies in is best. Many fish have hard, rough scales (i.e., perch, rockfish);

their scales will turn out well in prints and these fish are easiest to work with.

3. Lateral line: Most fish have a least one lateral line. The lateral line is a series of small organs used by the fish to sense turbulence and pressure changes. If you print correctly, the lateral line will be very striking in your prints.

4. Spines: Many fish have spines around the head. These spines can be poked through the paper. If properly printed, most of the fish's spines will reproduce beautifully.

5. Mucus: Fish secrete mucus from their bodies to protect themselves from parasites and disease and to help them "slip" through the water easily. The mucus tends to make a fish print less clear and dark in color. For this reason it is important to remove as much mucus as possible by washing the fish thoroughly. Mucus tends to collect on the fins, near the anus, gill cover, isthumus, and nostrils, and under the pectoral fins.

6. Body form: Fishes' bodies vary greatly in shape. A flat flounder lies on the ocean bottom, while a round, bullet-shaped tuna needs to swim efficiently to capture prey. Generally, the flatter the fish, the easier it is to print.

KEY

1.-6. Answers will vary depending upon the fish species used.

KEY WORDS - Gyotaku - Japanese Fish Printing

biologists
characteristics
distinquishing
endangered
gills
gyotaku
ichthyological
life history
spines

GYOTAKU - JAPANESE FISH PRINTING

The techniques of Japanese fish printing have been used in Japan for over 100 years. They are used to record catches of sports fish. They also help to gain ichthyological (fish biology) information. These prints have been used at the University of Washington. Biologists use them to study fish.

The art of gyotaku (ghio-ta-koo) is a good way to gain an understanding of the beauty of marine animals. You can also use this technique for making prints of shells, rock, flowers and other items.

BEFORE YOU MAKE YOUR PRINT:

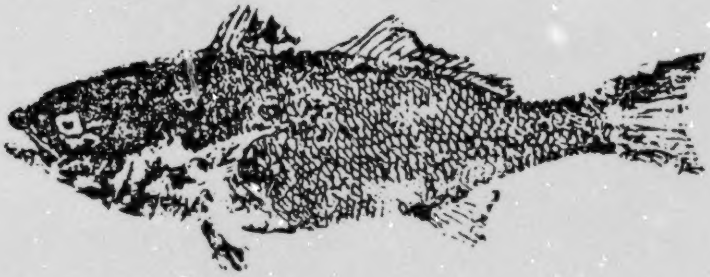
1. Identify your fish. What kind of fish is it?____________________
2. Where are these fish caught?____________________________________
____
3. How are these fish caught? (gill nets, etc?)____________________
____
4. What color (s) is your fish? ___________________________________
5. What are the distinguishing characteristics of the fish? (are there any spines, etc?____
____
____
6. What is the life history of this fish? (Where are the eggs laid, how do they develop? Where do the young fish spend their time, are the fish endangered? etc.) _____________________________
____
____

MATERIALS:

Obtain a very fresh fish. You may buy the fish at a market. Select one that has bright red gills, clear eyes, and a fresh, smell. The fish may have a cut up the middle. Make sure that it has not been cut anywhere else on the body.

You also need:

- newspaper
- plastic modeling clay
- pins
- water-base ink (linoleum block ink is best)
- a stiff ½" brush
- rice paper, newsprint, or other moisture tolerant paper. Since rice paper is expensive, you might prefer to start with newsprint.



METHOD:

1. Use soap and water to clean the outside of the fish as completely as possible. The cleaner the fish, the better the print. Dry the fish well.
2. Place the fish on a table covered with newspapers. Spread the fins out over some clay and pin them in this position. Continue to dry the fish.
3. Brush on a thin, even coat of ink. Leave the eye blank unless you prefer to fill it in.
4. Place a piece of newspaper or rice paper over the top of the fish.
5. Carefully lay the paper over the entire fish. Use your fingers to gently press the paper over the surface area of the fish. Be careful not to move the paper too much since this results in double prints. Then remove the paper and you have a fish print.
6. Use a small brush to paint the eye.
7. Wash off the fish and prepare it for dinner.

TEACHER BACKGROUND - Word Search

This word search is a vocabulary reinforcing device using words important in the text. In this particular word search all words are either vertical or horizontal. There are no diagonal words and all words are spelled forward.

Students may work on this as individuals or you may elect to have them form small groups. Alternatively, they may work on them independently, then meet in small groups to discuss their answers. At the conclusion of the activity, you should spend a moment reviewing the correct locations and the meanings of the words circled.

WORD SEARCH - Teacher Key

```
                          A
                          N
                      H   C
        S           F A T H O M
      G K S A L M O N L   O S I
      I A   L   C     I   R P G
      L T   B U O Y   B   T A R
      L E   A   R     U   R W A
      N L   C   K     T   O N T
      E I   O   L W E I R L I I
      T N   R   I         L N O
P U R S E S E I N I N G   I G N
        S     L E A D L I N E
                          G
```

KEY WORDS

albacore

anchor

buoy

cork line

fathom

gill nets

halibut

lead line

migration

purse seining

salmon

skate lines

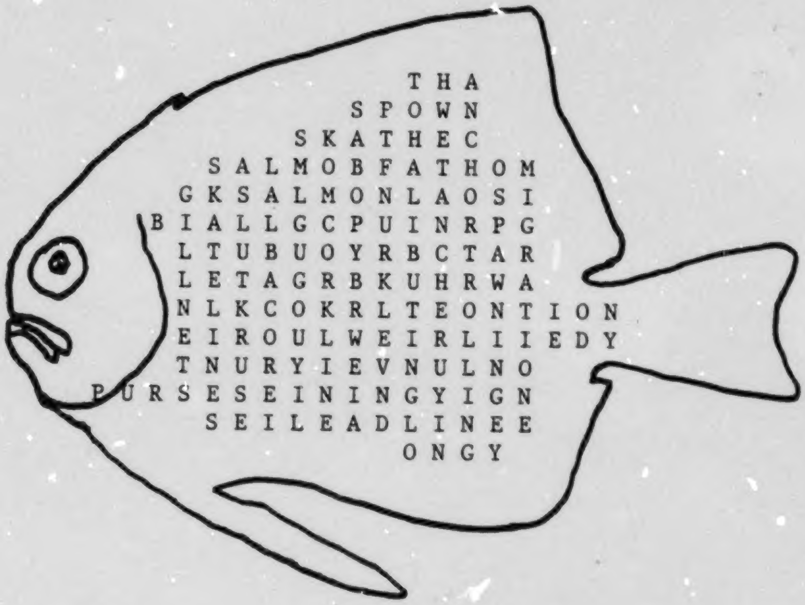
spawning

trolling

weir

WORD SEARCH

Find the words listed on the right in the word search inside the manefish. Circle the words as you find them.



```
                      T H A
                  S P O W N
              S K A T H E C
        S A L M O B F A T H O M
      G K S A L M O N L A O S I
    B I A L L G C P U I N R P G
      L T U B U O Y R B C T A R
      L E T A G R B K U H R W A
      N L K C O K R L T E O N T I O N
      E I R O U L W E I R L I I E D Y
      T N U R Y I E V N U L N O
P U R S E S E I N I N G Y I G N
        S E I L E A D L I N E E
                      O N G Y
```

ALBACORE
ANCHOR
BUOY
CORK LINE
FATHOM
GILL NETS
HALIBUT
LEAD LINE
MIGRATION
PURSE SEINING
SALMON
SKATE LINES
SPAWNING
TROLLING
WEIR

SUGGESTED ADDITIONAL ACTIVITIES

1. Visit your local seafood market and make an inventory of the various kinds of seafood and their sources.
2. Visit a seafood processing plant and list the steps involved in processing.
3. Visit a shipyard or drydock and observe the various skills and tools needed in construction and repair.
4. Request a fisheries patrol officer to speak to the class concerning regulations governing and protecting fish and shellfish.
5. Go to a marina and visit a fishing vessel and list those things a fisherman must know and the variety of tasks he must be able to do.
6. Visit a fish hatchery and describe the life cycle of a salmon.

AQUACULTURE AND MARICULTURE

TEACHER BACKGROUND - Aquaculture and Mariculture

Aquaculture and mariculture programs are relative newcomers to the aquatic environment. More will be heard of these fields in the not-too-distant future. It is important to heed the words of a salmon mariculturalist, Jon M. Lindbergh when discussing this topic with your students:

> If the mariculture of fish, shellfish, and plants is successful, what does this mean to the world of the future? Statesmen of note have pronounced that, between the farming of seafood and more efficient harvesting of what is found in the wild, the oceans are the answer to the population explosion. That is a short-sighted and most dangerous illusion. Wild harvests now seem to be close to their maximum sustained yield. Mariculture, in its infancy, is quite costly. It provides food for the gourmets, but not for the masses.
>
> So, at present, mariculture provides a welcome addition to the diets of those who enjoy and appreciate seafood. As techniques and efficiency improve, it may provide lower-cost protein which may give us a little more time to learn to stabilize our world population. But to accept mariculture as a panacea to population expansion is simply to pass this most crucial of problems on to our children. Such procrastination is simply to encourage still more people to a day when there is no new ocean to exploit.

Duplicate the text pages. One set per student is recommended. This section has several subsections which lend themselves to individual assignments. Preview the section and divide it in a manner that works for your class. Regardless of the approach, plan to allow time for discussion of the concepts developed here.

KEY

1. Mariculture refers to raising crops in salt water only, while aquaculture, a more generalized term, refers to raising them in fresh or salt water.

2. If all the oysters in an area were male, there would be no possibility of reproduction. Some of the males, then, would change to females. This question is simply the reverse situation to that described in the text.

3. a. Adult oysters usually live attached to the bottom.

b. From the context of the reading, your students should be able to determine that larvae are free-swimming oyster young. Actually, "larva"(singular, larvae-plural) refers to the early, free-living immature form of any animal that changes structurally when it becomes an adult.

c. The clean, hard surfaces where oysters settle are called cultch (the correct answer is underlined).

d. Oysters are ready for harvest two to four years after they are planted (the correct answer is underlined).

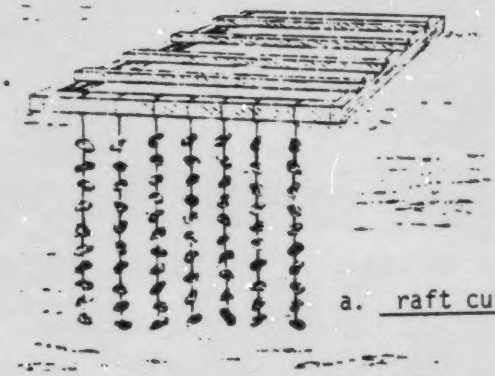
4. When oysters are very small they are fed plankton (the correct answer is underlined).

5. Baby oysters are called "larvae" (the correct answer is underlined).

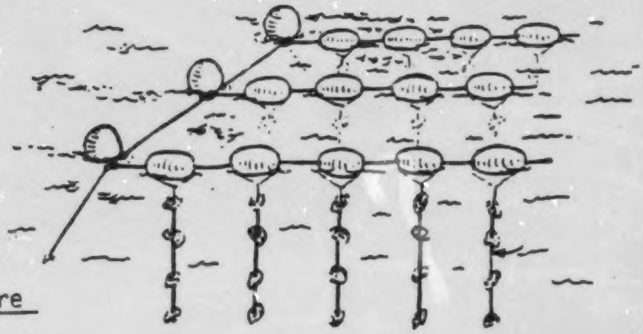
6. When baby oysters set on shells to grow they are called "spat" (the correct answer is underlined).

7. Bottom grown oysters which are exposed to air during low tides must remain closed and not feeding during these periods of exposure. Since oysters hung from racks in deeper water can feed around the clock, they tend to grow more rapidly.

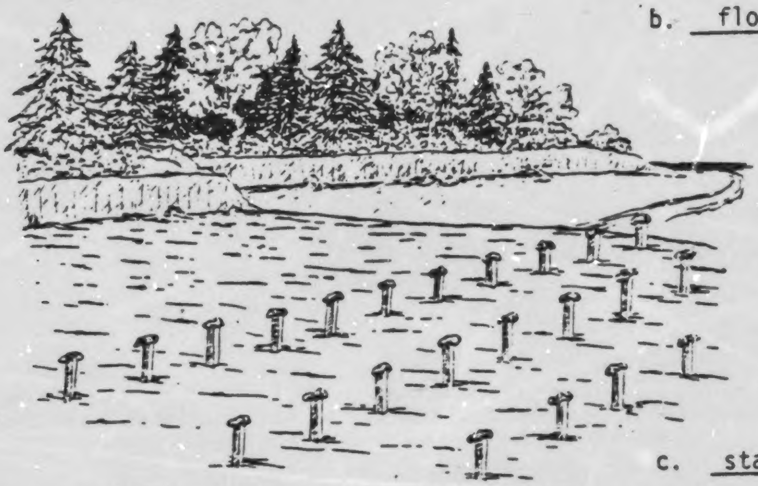
8.



a. raft culture



b. float culture



c. stake culture

9. a. Mussels grow highest up the beach.

b. The geoduck is the largest clam.

c. From the drawing, cockles, native littleneck clams, and eastern softshell clams would be found growing near oysters. In real life, these four shellfish choose different kinds of bottom on which to settle. As such, it would be unlikely to find all in the same spot. These shellfish do, however, all live within the same tidal zone.

10. An aquaculturalist is a farmer who raises aquatic life. This question refers to information presented earlier in the section.

11. Your students will probably have a variety of suggestions from painting the hatchery salmon to injecting them with radioactive substances. Actually, most everything they will suggest has been tried. The most widely used method now involves injecting a tiny piece of wire into the space between the fish's eyes. The wire carries a code that tells when and where the fish was raised. The adipose fin, a small fleshy fin on the underside of the salmon, is also clipped off. The missing fin is a clue to fishers that the fish they have caught is carrying a coded wire tag.

12. a. The open arrows show the hatchery cycle.

b. In the hatchery cycle, salmon young hatch in troughs or trays (the correct answers are underlined).

c. Hatchery salmon grow to migration size in hatchery ponds and/or natural ponds (the correct answers are underlined).

d. Both hatchery salmon and wild salmon grow to adulthood in the ocean.

13. Many sports fishers are opposed to sea ranching because they believe sea ranch operations will reduce available fish to the river mouths, etc. They also believe sea ranch raised salmon will compete for available food resources in the ocean.

14. a. Oregon Aqua obtains eggs from their returning salmon or from state and federal hatcheries.

b. The yolk sac provides food for the developing fish. Your students will have to infer this from the statement that the fish begin to feed after the yolk sac is absorbed.

c. The feed pellets are made from fish scrap, shrimp or crab wastes (the correct answer is underlined).

d. The salmon are imprinted from 7 to 35 days at South Beach.

e. Imprinted Oregon Aqua salmon return to the Oregon Aqua pens as adults. This is the point that has caused concern among fishers.

f. One to six fish per hundred are expected to return (ie. 1% - 6%). Two to four fish per hundred is assumed for the "business model" used to determine whether Oregon Aqua would be profitable.

g. The returning salmon will "bright and high-value".

h. "Portions" refers to individual serving size pieces of salmon. Most institutions including hospitals, restaurants, etc., prefer to purchase uniform sized portions of fish or other commodities to reduce their waste and effort. This answer will require some interpretation from the information provided in the text.

15. Some of the jobs mentioned that relate to raising "pan-sized" salmon include: diver, driver, processor, researcher, administrator, pen makers, and feeder makers.

16. The correct sequence is shown below:

5 "Baby salmon" are marketed
3 salt water cultivation
1 incubation
2 fresh water cultivation
4 harvest

17. When salmon first hatch from eggs, they live in fresh water (the correct answer is underlined).

18. If the sun rises at 6:00 a.m. and sets at 8:00 p.m. there are 14 hours of daylight on May 31. Since the salmon are fed every fifteen minutes or four times per hour, salmon would be fed 56 times on May 31. The work might look like the following:

6:00 a.m. to 8:00 p.m. = 14 hours daylight on May 31

$$\frac{\text{14 hours} \times \text{60 minutes/hour}}{\text{15 minute feedings}} = \text{56 feedings on May 31}$$

19. Three jobs involved in harvesting plate-size salmon include: dipping the salmon from the pens with nets, cleaning the salmon, weighing and freezing the cleaned salmon, and trucking the salmon to market.

20. a. The brand name of the product is "DomSea". You may need to help your students with the term "brand name".

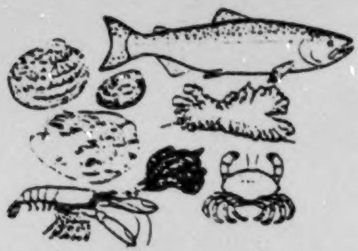
b. The salmon are fresh/frozen but taste fresh/frozen (the correct answers are underlined).

21. Three animals raised by mariculture would include: oysters, clams, salmon. Scallops, mussels, lobsters, and abalone are also raised by mariculturalists.

22. Since mariculture is providing food for gourmets and not for masses of people, it is not likely to be an answer to world hunger.

KEY WORDS

aquacultural
aquaculture
attachment
brand name
controlled environment
cultch
culture
distribution
fertilization
finances
gourmets
habitat
harvest
hatchery
heat exchanger
imprinting
incubation
larva
life cycle
mariculture
migration
natural reproduction
over population
oysters
"pan-sized" salmon
pellets
pen-culture
plankton
primitive
protein
rearing
restore
return rate
sea ranching
settlement
silt
smolts
smothered
spat
spawn
stage
stakes



AQUACULTURE AND MARICULTURE

Man has harvested fish for food for thousands of years. The ways we harvest fish today are much the same as the ways used by primitive fishers. These methods let us catch as many fish as natural reproduction can replace. The numbers of these fish get smaller each year. People are working to increase the supply of food from the sea. Aquaculture and mariculture programs are being started.

Aquaculture and mariculture are types of farming. The farmers raise aquatic (water) life. This done within a controlled environment. The life cycle of the plant or animal takes place in the controlled environment. Mariculture is a type of farming done only in salt water. Aquaculture is water farming in either salt or fresh water.

Aquaculture projects usually need certain things to be successful. Several permits are required before an aquaculture project can begin. Proper water temperature is important. Rate of water flow is also very important. Specialized equipment and often an expensive source of food are necessary. These require a sizeable amount of money to begin a project.

1. What is the difference between aquaculture and mariculture?

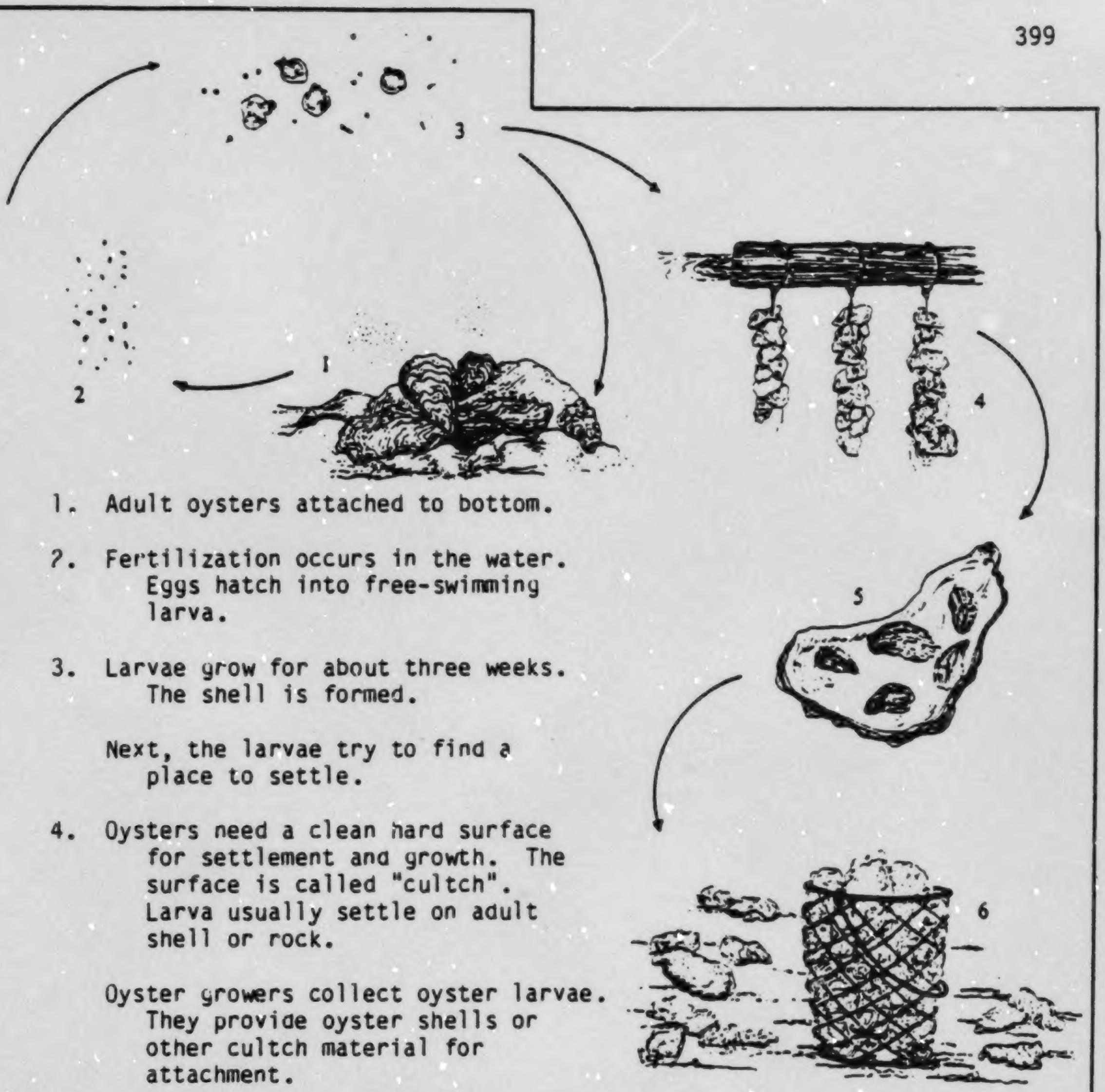
Oyster Farming

Oysters have been farmed for many years. Oyster farming projects need trained and experienced people. People must know about the life history of the oyster. Let's start with adult oysters.

Oysters, like most animals, are either male or female. Unlike most animals, however, oysters can change their sex. One year an oyster may be male, the next year female. Changing from male to female and back seems odd. What could be the advantage? Both females and males are needed to produce young oysters. Oysters don't move much as adults. What would happen if all the oysters in an area were female? No baby oysters would be produced. Clever oysters, some can change to male. The oysters are saved.

2. What would happen if all the oysters in an area were male?

The drawing on the next page shows the life cycle of the oyster. A life cycle shows the stages in an animal's life.



1. Adult oysters attached to bottom.

2. Fertilization occurs in the water. Eggs hatch into free-swimming larva.

3. Larvae grow for about three weeks. The shell is formed.

   Next, the larvae try to find a place to settle.

4. Oysters need a clean hard surface for settlement and growth. The surface is called "cultch". Larva usually settle on adult shell or rock.

   Oyster growers collect oyster larvae. They provide oyster shells or other cultch material for attachment.

5. Cultch containing "seed" (young) oysters is moved to oyster farms.

6. Oysters are planted on rearing beds. In two to four years, they are ready for harvest. Once planted they remain attached for the rest of their lives.

OYSTER LIFE CYCLE

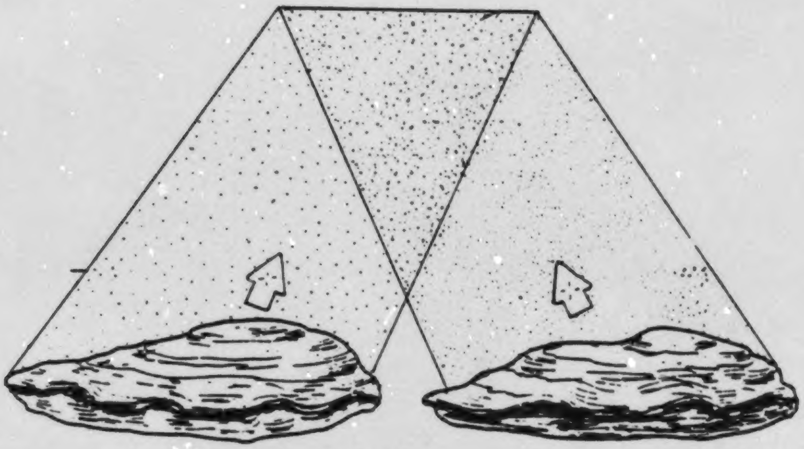
3. Use the life cycle drawing above to answer these questions.
   a. Where do adult oysters usually live?
   b. What are larvae?
   c. The clean, hard surfaces where oysters settle are called

      ____
   d. Oysters are ready for harvest ____ to _____ years after they are planted.

The life cycle drawing shows natural settlement of oysters. Many oyster farmers get their "seed" oysters in this way. Some aquaculturalists, however, raise oysters from the free swimming stage. These oyster larva are raised in large tanks of sea water.

People must know how to prepare special foods. The baby oyster larva eat plankton. They must be careful. Some foods will eat the oyster larvae. Experience is needed to make and run sea water systems. Water temperature is very important. Therefore, someone needs to be skilled in the operation of heat exchangers. They are used to heat large quantities of water. Boats and heavy equipment are used daily. They move oyster shells and rafts of oysters from place to place.

4. When oysters are very small they are fed ________________

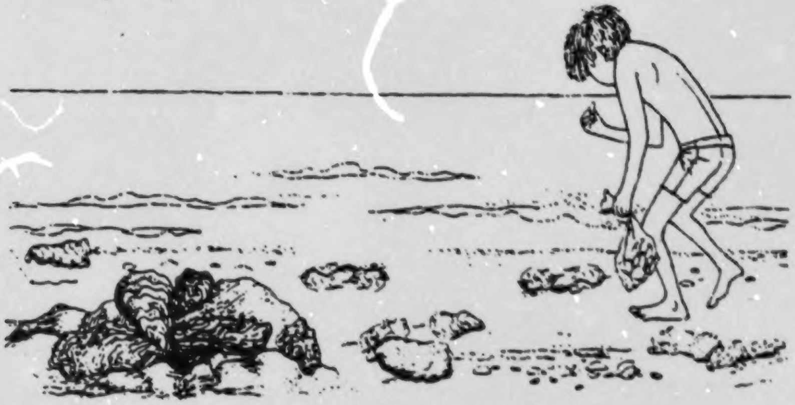


After spawning, the oyster larva (baby oysters) drift in large tanks of sea water. They drift for several days. They are fed phytoplankton (small drifting plants). Soon they reach an important stage of development. Clean empty oyster shells are then put into the tanks. This gives the oyster larvae something to set on. Then the oyster larvae set on the shells. At this point they are called oyster "spat". This spat is often sold to oyster farmers. Some of the oyster spat are placed in oyster beds. Others are placed on oyster strings. Now, they are left to grow. It will be two to four years before they are harvested.

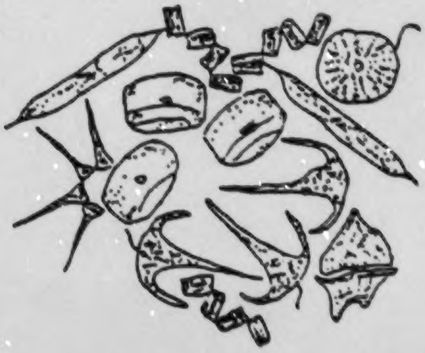
5. Baby oysters are called ______________________

6. When the baby oysters set on shells to grow they are called ________________

There are lots of ideas about the best way to grow oysters. The easiest method is growing oysters on the bottom. Shells containing seed oysters are on the bottom. If the bottom is rocky or hard, the shells may be washed away.

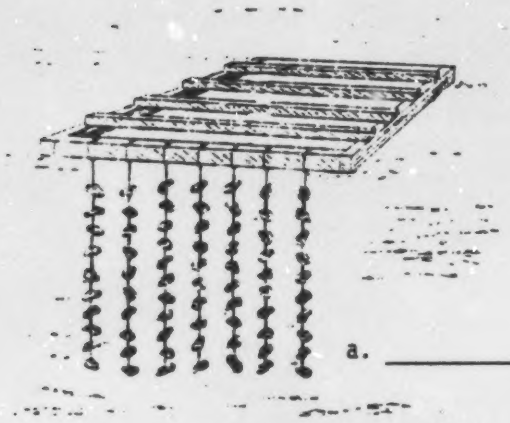


Some farmers place single oyster shells on stakes. The stakes are driven into the sand. Other farmers string the shells on ropes. The ropes are hung from floating rafts. They may also be hung from racks or floats. Some people use special nets to hold the oyster shells.

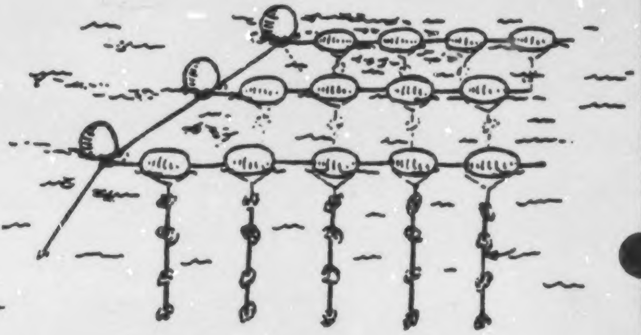


7. Adult oysters eat plankton. They filter the plankton from the water. Oysters on the bottom are exposed to air during low tides. Why might bottom grown oysters grow slower than those hung from racks?

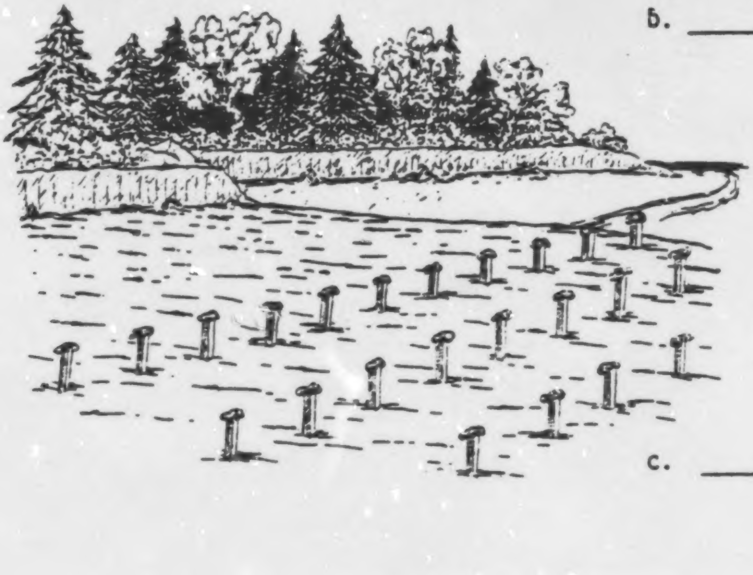
8. The next three pictures show different oyster culture methods. Label: stake culture, float culture, and raft culture.



a. ____________



b. ________________

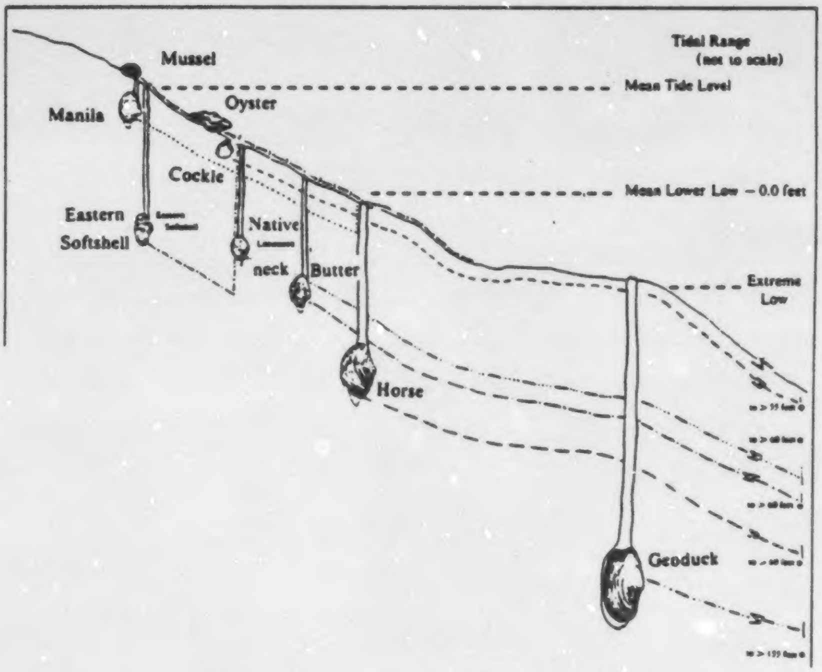


c. ________________

Clam Farming

Clams have been cultured in Japan for over 1000 years. Oysters started being cultured in Japan about 1673. A clam farmer found oysters growing on a fence around his clams! Clams may be raised much like oysters. However, clam larvae do not need cultch for settlement. After settling, young larvae can both swim and crawl. During this time, they try to find a suitable habitat. Those that succeed grow to adults.

9. The following drawing shows a cross section of a beach.


Tidal Range
(not to scale)
Mussel
Mean Tide Level
Manila
Oyster
Cockle
Mean Lower Low – 0.0 feet
Eastern
Softshell
Native
neck
Butter
Extreme
Low
Horse
Geoduck

Use the drawing to answer these questions:

a. Which shellfish grows highest up the beach?

____

b. Which is the largest clam? ______________

c. Which kinds of shellfish would you find growing near oysters?

A.

B.

C.

Salmon Raising

Salmon are one of the most popular fish to eat. Lots of restaurants and stores sell salmon. Many people are involved in growing salmon. Salmon raised by aquaculturalists add to those raised by nature.

10. What is an aquaculturalist?

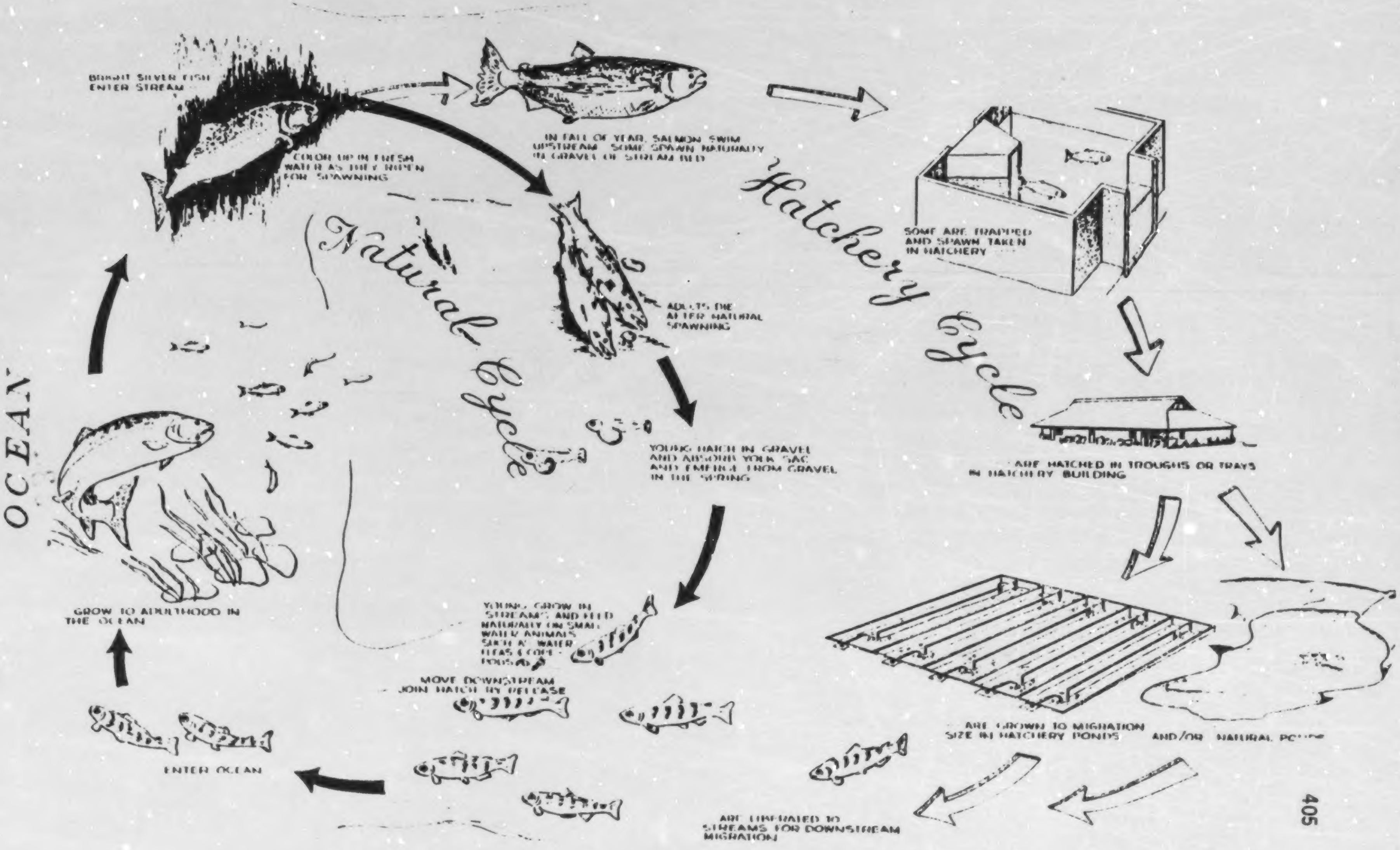
Aquacultural programs range from hatcheries to pen rearing. Let's begin by looking at a hatchery operation.

A hatchery is a place where salmon eggs grow to small fish. Most hatcheries are government run. Salmon eggs are taken from female salmon. The eggs are fertilized and raised. What is the idea behind hatcheries? Some scientists think that larger fish have a better chance of survival. Fish hatched in the wild are small. Many are eaten. Hatchery fish are larger when released into streams. Many of them are eaten, too. But fewer are eaten than of the small salmon.

11. Not everyone is convinced about hatcheries. It is hard to keep track of salmon released from hatcheries. How might you mark salmon so biologists can recognize where they were raised?

12. The picture on the next page shows salmon life cycles. Use the drawing to discover more about hatcheries.

Natural and Artificial Salmon Cycles


BRIGHT SILVER FISH ENTER STREAM
COLOR UP IN FRESH WATER AS THEY RIPEN FOR SPAWNING
IN FALL OF YEAR, SALMON SWIM UPSTREAM. SOME SPAWN NATURALLY IN GRAVEL OF STREAM BED
Hatchery Cycle
SOME ARE TRAPPED AND SPAWN TAKEN IN HATCHERY
Natural Cycle
ADULTS DIE AFTER NATURAL SPAWNING
OCEAN
YOUNG HATCH IN GRAVEL AND ABSORB YOLK SAC AND EMERGE FROM GRAVEL IN THE SPRING
ARE HATCHED IN TROUGHS OR TRAYS IN HATCHERY BUILDING
GROW TO ADULTHOOD IN THE OCEAN
YOUNG GROW IN STREAMS AND FEED NATURALLY ON SMALL WATER ANIMALS SUCH AS WATER FLEAS & COPEPODS
MOVE DOWNSTREAM JOIN HATCHERY RELEASE
ARE GROWN TO MIGRATION SIZE IN HATCHERY PONDS AND/OR NATURAL PONDS
ENTER OCEAN
ARE LIBERATED TO STREAMS FOR DOWNSTREAM MIGRATION

a. The dark arrows show the salmon's natural life cycle. What do the open arrows show?

b. Adult salmon enter the stream where they were hatched. Some salmon are trapped and taken to hatcheries. Other salmon swim further upstream. In the natural cycle, salmon young hatch in the gravel. In the hatchery cycle, salmon young hatch in ___________ or

____

c. Where do hatchery salmon grow to migration size?

A.

B.

d. The young, wild salmon migrate (move) downstream. The hatchery salmon are released into streams. They migrate downstream also. Where do both kinds of salmon grow to adulthood?

Millions of salmon are raised in hatcheries each year. Salmon from hatcheries have helped restore fish streams. Even so, some people worry about hatcheries. They wonder if the fish populations are harmed. Scientists are now looking at the effect of hatcheries. Their research should help answer the questions.

Sea Ranching

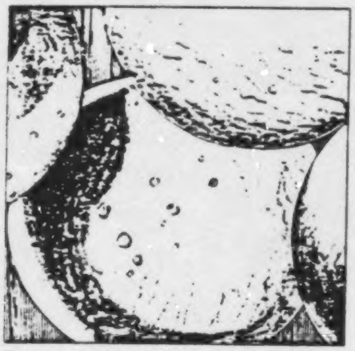
Hatchery raised salmon are usually released into streams. Once in the streams, they join wild salmon. From there on they face all the same hazards. A new industry called sea ranching uses a different approach.

Sea Ranchers raise the small fish until they are ready for saltwater. They then hold the small fish, called smolts, in pens. The fish then are released into the ocean.

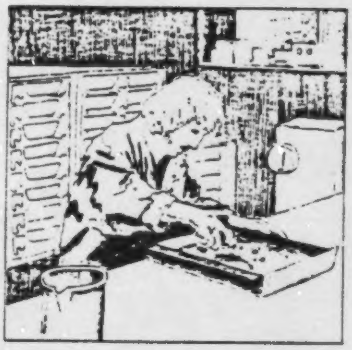
In the ocean, the fish grow to adult size. As adults they return toward shore to reproduce. Here is a major difference. The salmon return to the salt water pens instead of to a stream. When they're in the pens, they can be easily harvested.

13. Sports fishers usually fish close to shore. Often they fish at the mouths of streams. Many times they fish in the stream. Why are many sports fishers opposed to sea ranching?

14. The following drawings describe "Oregon Aqua's" sea ranch operation. Use the drawings to answer the questions.

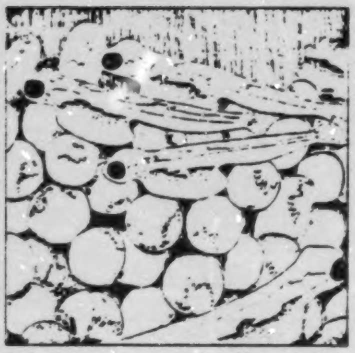


Salmon eggs are gathered from Oregon-Aqua's returning salmon or purchased from state and federal agencies.

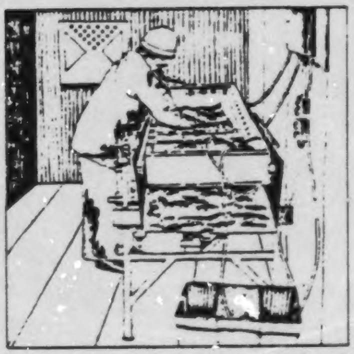


Fertilized eggs are incubated in these trays. Water must be pure and of the appropriate temperature.

BEST COPY AVAILABLE



Eggs are maintained under carefully controlled conditions to produce these sac-fry. When the yolk sac is absorbed, the fry will begin to feed.



Fish scrap, shrimp or crab waste, and a variety of vitamins and minerals are blended and formed into feed pellets. The pellets are made in varying sizes to accommodate varying fish sizes.

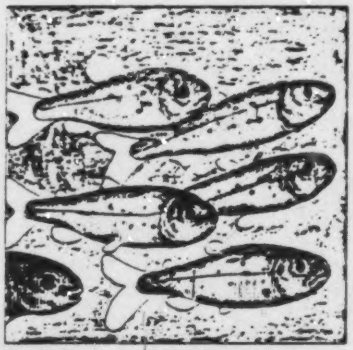
a. Where does Oregon Aqua obtain eggs?

A.

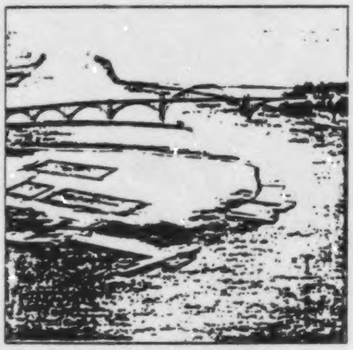
B.

b. What does the yolk sac provide the young fish?

c. The young salmon eat feed pellets. The feed pellets are made from ______________________________
A variety of vitamins and minerals are added to the mix.

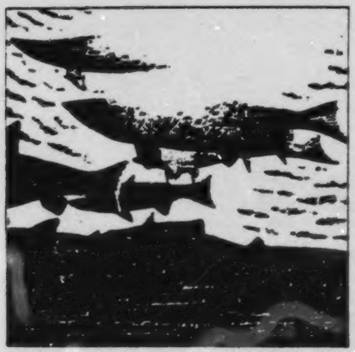


Salmon smolts, ready for saltwater, are transferred by truck from the freshwater hatcheries to the South Beach saltwater facility for further growth and imprinting. Over a 7- to 35-day period, they become *imprinted* with the odor and location of this facility and thus return here as adults.

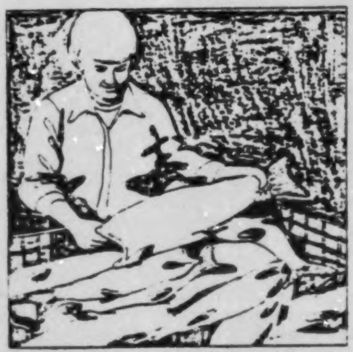


Our South Beach facility is close to the Pacific. In this way, uniform ocean water is provided the salmon. Also, released smolts and returning adults are subject to less predation and loss.

BEST COPY AVAILABLE



Adult salmon will return to our facilities in 18 to 42 months, depending upon species. Return rates will be 1% - 6%; we're assuming 2% - 4% for the business model. Salmon returning to the South Beach saltwater facility will be bright and high-value.



An ocean-ranched product, such as this, can be processed and handled in conventional fashion, somewhat like logs. Or, alternatively, it may be reduced to "portions," a desirable form for the institutional trade.

d. "Imprinting" refers to fish "remembering" their home. How many days does it take to imprint salmon at South Beach?

e. To where do the imprinted Oregon Aqua salmon return?

f. "Return rate" refers to the number of fish coming back. For a 1% return rate, one fish returns for every 100 released. How many fish per hundred are expected to return?

g. What will the returning salmon be like?

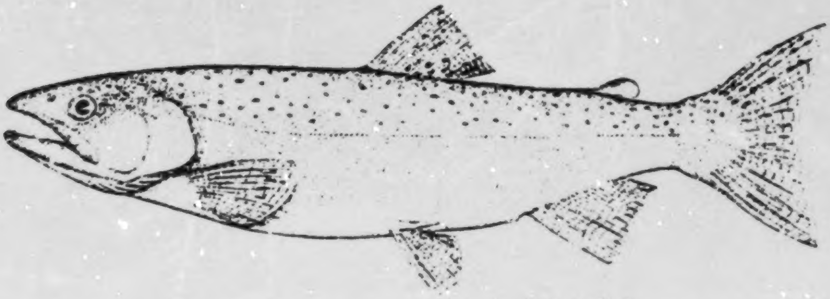
h. What do you think is meant by "portions"?

Salmon ranching is a relatively new business. If it proves successful, it may change salmon fishing as we know it. Time will tell. In the meanwhile, watch newspapers and magazines for stories about sea ranching.

BEST COPY AVAILABLE

"Pan-sized" Salmon

Pen-culture is another way to grow salmon. This method raises "pan-sized" salmon. These salmon spend their entire life cycle in captivity. "DomSea" farms pen-cultures salmon. About 100 people work for "DomSea" farms. Divers, processors, drivers, researchers and administrators all help. Together they produce and market salmon.



Coho Salmon

Workers must have a variety of talents and training. People need to make pens and feeding devices. They need to know how to spawn and care for the baby fish. Some must know how to fight fish diseases. Some must prepare the fish food diet. Others need training in scuba diving. Divers must dive to the bottom of the pens to clean and repair the nets.

Some people clean and process the fish for marketing. Others operate boats and large trucks. The trucks carry the fish, food and gear.

Still others are trained in business. These people handle the finances. This includes selling the fish. Some fish are sold to restaurants. Others are sold to large seafood distribution centers. The fish are sold all over the world.

15. What are three jobs related to raising "pan-sized" salmon?

a.
b.
c.

The captive life cycle has four stages. The stages are incubation, freshwater cultivation, saltwater cultivation, and harvest. After harvest, the "Baby or Mini" salmon are marketed.

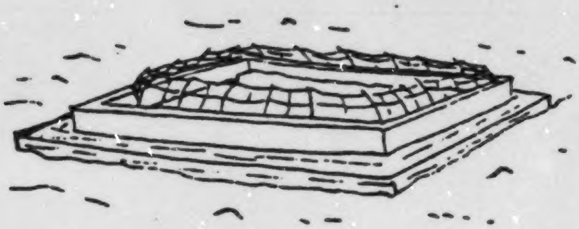
16. The following list shows the stages in raising salmon. Write the number one in the space in front of the first stage. Continue with the second and following stages.

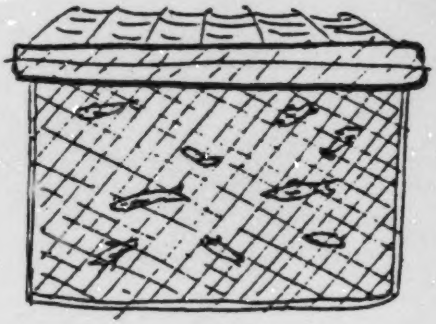
_____"Baby salmon" are marketed
_____saltwater cultivation
_____incubation
_____freshwater cultivation
_____harvest

Pink eggs begin their life cycle in hundreds of trays. This is the incubation stage. The "nursery" has soft lighting and low noise. The eggs are bathed in freshwater. Every day someone removes dead eggs. Workers maintain the correct water temperature. They keep the eggs from being smothered by silt (fine dirt).

17. When salmon first hatch from eggs, they live in
water.

After hatching, the fish are kept in freshwater ponds. The young fish must be fed very often. Food is spead automatically over the ponds every fifteen minutes. The fish grow to the smolt stage.





The young fish are moved to saltwater pens. They are fed and cared for daily. Biologists watch for disease. Natural enemies such as birds and dogfish sharks are also problems.

18. The salmon eat from sunrise to sunset. They are fed every fifteen minutes. On May 31, the sun rises at 6:00 a.m. and sets at 8:00 p.m. How many times would the salmon be fed on May 31? Please show your work.

When the salmon are plate-size, they are harvested. They weigh about three-fourths of a pound. It takes about two and one half years to reach this size. It only takes about four hours to harvest the salmon. Workers use long handled nets to dip salmon from the pens. Other workers clean the salmon. The cleaned salmon are weighed and frozen. Truckers carry the frozen salmon to markets across the country.

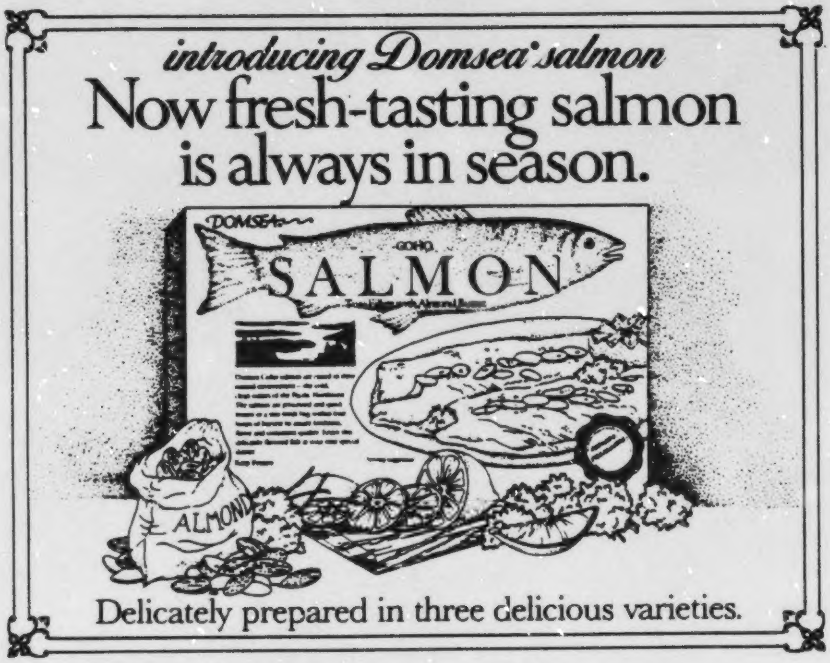
19. What are three jobs involved in harvesting plate-size salmon?

a.

b.

c.

20. The following ad is from a Washington, D.C. magazine. Use the ad to answer these questions.



introducing Domsea® salmon

Now fresh-tasting salmon is always in season.

Delicately prepared in three delicious varieties.

a. What is the brand name of the product?

b. The salmon are fresh/frozen but taste fresh/frozen (circle the two correct answers.

Raising salmon requires much work. After harvesting and processing, the cycle starts all over again.

Most of today's mariculture projets are small. What will it mean to the future if the mariculture of fish, shellfish, and plants is successful? Mariculture is quite costly. It provides foods for gourmets. It does not provide food for masses of people. As methods improve, mariculture may help provide lower cost protein. Mariculture cannot cure food problems due to over-population. Mariculture may help but it cannot solve the problem.

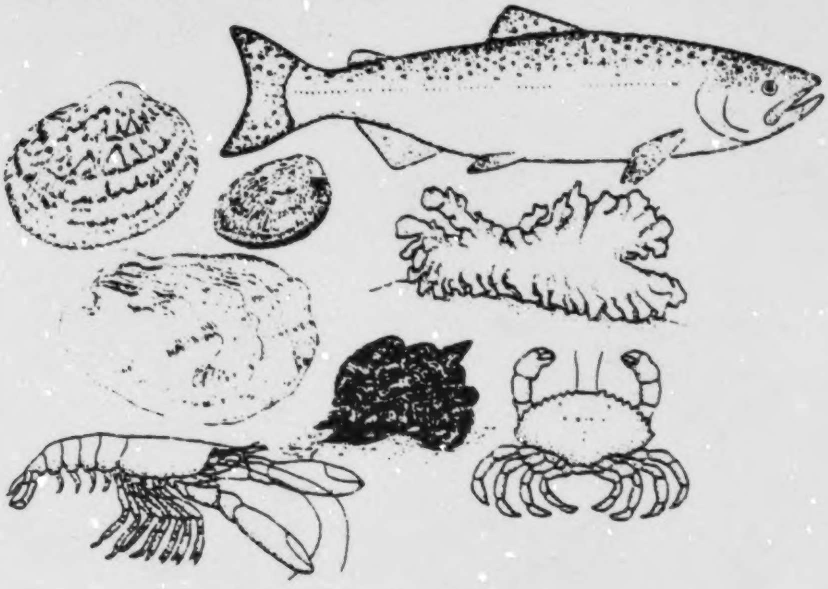
21. What are three marine animals raised by mariculture?

    a.

    b.

    c.

22. Will mariculture be the answer to world hunger?



Some Mariculture Foods

TEACHER BACKGROUND - Open for Business

This activity permits your students to make some simple economic comparisons of two hypothetical businesses. The activity also provides some practice with practical word problems. Again, the choice is up to you regarding how to handle the activity. You may elect to have the students work independently or in small groups. Each student or group should have a copy of the exercise. Duplicate the needed material prior to class use.

KEY

1. 1,500 lbs x $2.00/lb. = $3,000.
2. 800 lbs. 3.00/lb. = $2,400.
3. SEASALMON FARMS, INC. looks like the best investment.
4. $250.00 + $1,000 + $300.00 = $1,550.
5. $75.00 + $200.00 + $600.00 = $875.
6. SEASALMON FARMS has the greatest expenses for one year.
7. $3,000 - $1,550 = $1,450.
8. $2,400 - $875.00 = $1,525.
9. WATERBED OYSTER CO. has the largest net profit.
10. The best investment is the WATERBED OYSTER CO.

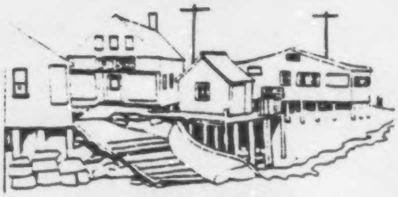
KEY WORDS

expenses

income

investment

net profit



OPEN FOR BUSINESS

Lucky you! You have just won one thousand ($1,000) dollars in the MacDonald's "Name That Burger" contest. Since you are now a rich person, all of your friends want to help you spend your money. You have decided to start a business. There are two choices which sound good to you. One is a salmon farm. The other is an oyster bed. You will have to use the information below to pick which business to buy.

SEASALMON FARMS, INC.

Income:	
Pounds of salmon sold a year	1,500
Price per pound	$2.00
Expenses:	
5,000 salmon eggs	$250.00
Fish food	$1,000.00
Packing and delivery	$300.00

WATERBED OYSTER CO.

Income:	
Pounds of oyster meat sold a year	800
Price per pound	$3.00
Expenses:	
Oyster spat	$75.00
Oyster shells	$200.00
Shucking and delivery	$600.00

PLEASE SHOW YOUR WORK

1. What is the total income of the SEASALMON FARMS, INC. for one year? (Hint: Multiply the number of pounds times the price per pound.)

2. What is the total income of the WATERBED OYSTER CO. for one year?

3. From the total incomes, which business looks like the best investment for your winnings?

4. What are the total expenses for SEASALMON FARMS, INC. for one year? (Hint: Add each expense item to find the total.)

5. What are the total expenses for WATERBED OYSTER CO. for one year?

6. Which business has the greatest expenses for a year of operation?

As president, your salary will be the NET PROFIT from the operation of your business. Net profit is the total income minus the total expenses.

7. What is the net profit for SEASALMON FARMS, INC. for one year?

8. What is the net profit for WATERBED OYSTER CO. for one year?

9. Which business has the largest net profit?

10. Which business is the best investment?

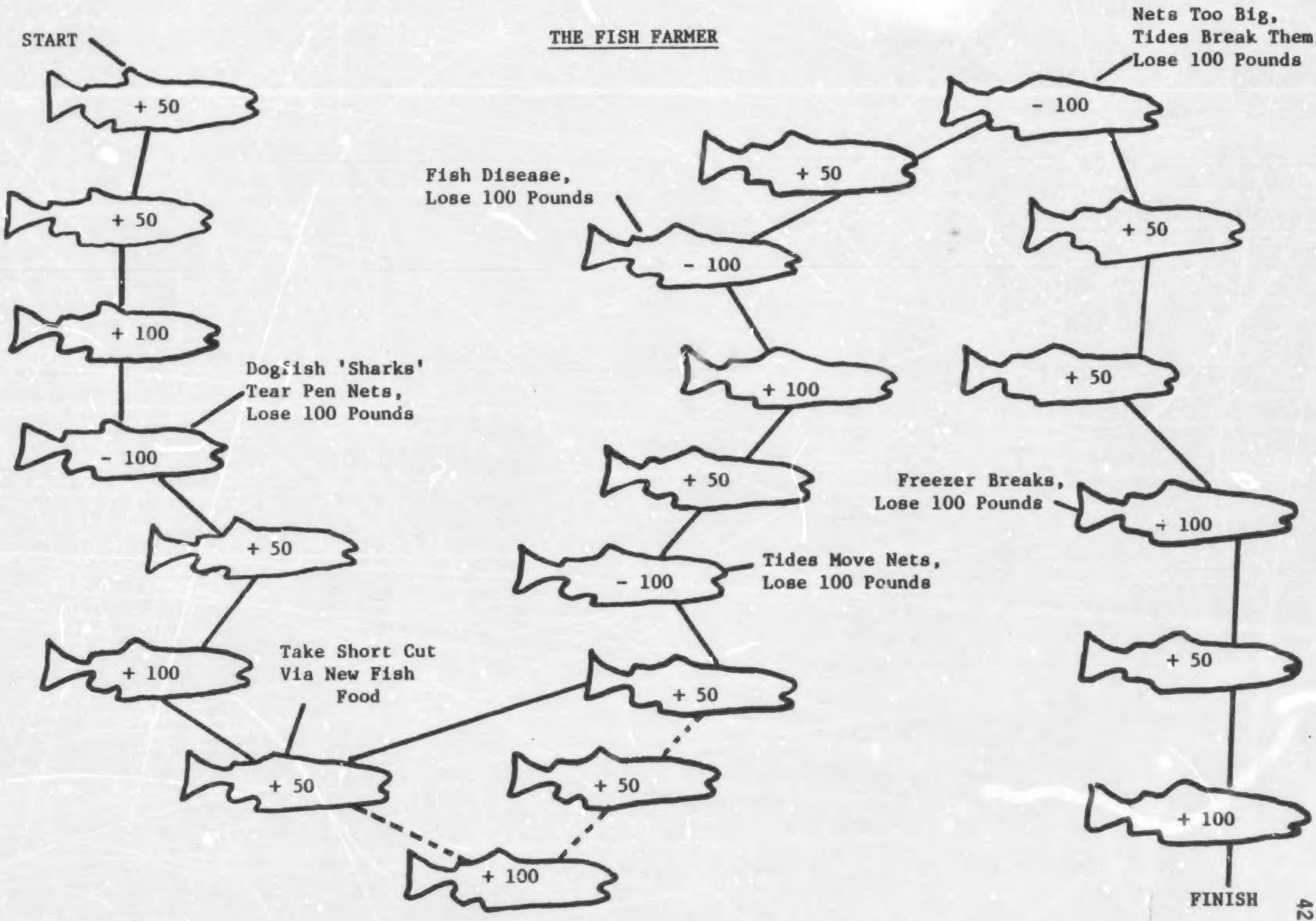
GOOD LUCK AND DON'T FORGET TO HAVE A GRAND OPENING SALE!

TEACHER BACKGROUND - Fish Farmer

The game is best played in groups of two. The game board and cards can be easily duplicated to obtain enough materials. The cards are stacked face down on the board. Playing order is determined by the toss off a die. Player two picks a card off the top and reads the problem and question to Player One. Player One must work out the problem (on paper or "in head") and respond with the answer. Player two verifies the answer. If the answer was correct, Player One may advance his marker forward on the game board the number of pounds of his answer. (i.e. if his answer was 100 pounds, Player One would move 100 pounds worth of fish on the board, perhaps two 50 pound fish. The value of the fish is listed inside of the fish.) The object of the game is to reach the finish first. After Player Two has posed the question and Player One has responded, the roles are reversed and the game is continued until one player reaches the finish. That player is the winner.

Additional clue cards make many new games possible. The cards may be modified to suit any type of math problems the class is working with. The clue cards may also be changed to allow this game board to be used as a reading game, etc.

THE FISH FARMER


START
+ 50
+ 50
+ 100
- 100
+ 50
+ 100
+ 50
+ 100
+ 50
+ 50
- 100
+ 50
+ 100
- 100
+ 50
- 100
+ 50
+ 50
- 100
+ 50
+ 100
FINISH

Dogfish 'Sharks' Tear Pen Nets, Lose 100 Pounds

Take Short Cut Via New Fish Food

Tides Move Nets, Lose 100 Pounds

Fish Disease, Lose 100 Pounds

Nets Too Big, Tides Break Them, Lose 100 Pounds

Freezer Breaks, Lose 100 Pounds

THE FISH FARMER - DUPLICATE AND CUT OUT ALONG LINES FOR GAME CARDS

Bad tides, lose 135 pounds.

New feed, gain 235 pounds.

Net change?

Answer: 100 pounds gain

Bad choice of food, lose 242 pounds.

New shipment of fish, gain 42 pounds.

Net change?

Answer: 200 pound loss

Decrease pen size, gain 87 pounds.

Fix hole in net, gain 113 pounds.

Net change?

Answer: 200 pounds gain

Pen size too big, lose 66 pounds.

New fish medicine, gain 166 pounds.

Net change?

Answer: 100 pounds gain

New fish medicine, gain 54 pounds.

New fish food, gain 46 pounds.

Net change?

Answer: 100 pounds gain

Income tax refund, gain 245 pounds.

Fish disease, lose 45 pounds.

Net change?

Answer: 200 pounds gain

New freezer saves time, gain 67 pounds.

Fish disease outbreak, lose 17 pounds.

Net change?

Answer: 50 pounds gain

Current carries away pen, lose 73 pounds.

Warmer water, increase 173 pounds.

Net change?

Answer: 100 pounds gain

Dog fish tear net, lose 89 pounds.

New fish food, gain 189 pounds.

Net gain?

Answer: 100 pounds gain

New pens, increase 187 pounds.

New medicine, gain 13 pounds.

Net gain?

Answer: 200 pounds gain

TEACHER BACKGROUND - World in a Jar

"World in a Jar" provides your students with a chance to experience a microcosm of some of the problems encountered by aquaculturalists. Your students will have an opportunity to make inexpensive saltwater aquaria out of gallon jars. This activity has a lot of merit. If you cannot conceive of going through the effort to obtain saltwater and saltwater animals, please consider doing the activity with freshwater and feeder goldfish. Feeder goldfish are raised for feeding to other, larger fish. They are quite inexpensive. Since carp are raised commercially, completing this activity with goldfish (a member of the carp family) is not unreasonable.

One advantage to using gallon jars for aquariums is that one large air pump can supply several jars, and teams of students can maintain their own aquariums. With a series of gang valves, you can run 10 gallon jars off of one large, silent-type air pump. Although this type of pump is relatively expensive (about $20.00), it tends to last a long time, runs quietly, and can aerate a large quantity of water.

Sometimes individuals are willing to donate fish tanks and equipment to schools. Teachers might find tanks by placing ads in local newspapers. With a letter on school stationery to acknowledge the contribution, the donor can take a tax deduction, and the teacher gets a free aquarium.

Location

When selecting a site for your tank, remember that incandescent lights produce heat; fluorescent lights don't. A fluorescent lamp will stimulate the growth of algae on the walls of the tank without increasing the temperature. The algae can then be scraped off and studied under the microscope.

Volatile substances dissolve quickly in salt water. Fumes from paint and proximity to animals such as hamsters or mice can kill your marine animals. The waste products from these mammals dissolve in the air and subsequently find their way into your aquarium.

The Water

You can either use natural seawater for your aquarium or eliminate the problems of hauling water from the shore by using one of the synthetic sea salts that are available in pet stores. Seawater contains many types of salts in a delicate balance, so don't try to improvise with table salt (sodium chloride).

If you want to collect your own seawater, carry it in a plastic pail lined with a plastic trash bag. When the pail is full, simply close the top of the bag with a twist tie to keep the water from sloshing. One gallon of water weighs over 8 pounds, so don't fill the pail with more water than you can lift. Try to collect your water as far out from the shore as possible, because water near the shore tends to be more polluted.

Have your students fill the gallon jars only to their widest point. This will allow the maximum exchange between air and water and thus provide the best aeration.

If you use synthetic salts, follow the directions on the package. These synthetic salts do not contain the microscopic life and organic material essential to a healthy aquarium. The two week run-in period is designed to provide these materials. During this period the only tenant in the tank is a crab. Marine organisms produce ammonia as a waste product. In the open ocean, the poisonous ammonia is harmless because it is diluted by the great amount of water. In a small tank, ammonia can build up and kill the organisms. Crabs, which are extremely resistant to this buildup, can survive where other organisms would die. New tanks can also be started simply by seeding it with some gravel from another older tank that has already built up a population of bacteria.

Filtration and Aeration

Because salt water tends to hold less oxygen than fresh water, a salt water aquarium must have a good source of oxygen. Oxygen not only allows the fish to breathe, but also allows for the buildup of aerobic (oxygen-using) bacteria, which break down poisonous waste materials in the tank. Without these friendly bacteria, your tank would quickly poison itself. One type of bacteria, Nitrosomas, breaks the ammonia down into nitrites. A second type of bacteria known as Nitrobacters changes the nitrites to harmless nitrates. Most marine animals ae relatively tolerant to the buildup of nitrates, but the level should be reduced by changing about one-fifth of the water every 2 weeks.

The goldfish bowl filter recommended fits neatly into a 1-gallon jar. This type of under-gravel filter works as a biological filter system. The air pump forces air bubbles into the water. This air-water mixture is lighter than the plain water in the jar. The lighter air-water mixture rises to the top and forces the plain water down through the filter. Large waste particles are trapped by the gravel as the water passes through.

If your tanks include clams, mussels, barnacles, or sea anemones, avoid a system that filters all materials from the water. These animals are natural filters and will starve to death if the filters are too effective.

Substrate

Substrate is the material that covers the bottom of the tank. A good substrate for a marine tank is dolomitic limestone, which is available at a pet store, or crushed oyster shells which you can make yourself. If you are going to crush your own oyster shells, put the shells between a few sheets of newspaper and crush them with a hammer. The newspaper will make it easy to clean up, and, more importantly, it will prevent any pieces of shell from flying up into your eyes. Don't hit them too hard because you want to get pieces that are too large to fit through the openings in the filter. Also, there must be space for water under the filter. If the crushed particles are too small, cover the filter plate with a nylon stocking to reduce the size of the openings.

Before putting the gravel into the tank, rinse it with tap water until the runoff is clear. The layer of substrate should be about 2 inches deep. Most people have poor success trying to maintain marine plants, so you're better off without these. However, you should provide some plastic plants to provide hiding places for the animals.

Temperature

Most marine organisms tolerate a temperature range from 40-70 degrees F. and can tolerate gradual temperature changes. Try to pick the coolest location possible and turn your heaters down during the day and off at night.

pH Level

Scientists use the abbreviation of pH to tell how acidic or basic something is. Vinegar and lemon juice are examples of acids. Baking soda and ammonia are examples of bases. The pH scale runs from 0 to 14. Water with a pH of 7.0 is neutral. As the pH drops below 7, we say the substance is acidic. The lower the number, the more acidic it is. As it rises above 7, it becomes increasingly basic. For example, if a chemical has a pH of 13, it is base. A pH of 3 would make a substance or acid.

The pH of the water in your tank should range from 7.5 to 8.3. As the water in the tank ages, though, it has a tendency to become more acidic.

The dolomitic limestone or crushed oyster shell used as a substrate is important in maintaining the proper pH of your tank. It provides what scientists call a buffer. A buffer is a chemical that helps to keep the pH constant.

If you find that the pH of your tank is dropping, add a small piece of chalk or a little baking soda. Both of these substances are buffers. You can test the water by using pH paper or a pH test kit obtained from aquarium shops. Consider providing this equipment for your students. This will give them a chance to improve their observation and recording skills.

Density-Salinity

The density of something is how much a certain amount of that substance weighs in relation to its volume. Lead would have a high density because a cube that measures 1 inch on each side would be heavy; cotton would have a low density because a cube that measures 1 inch on each side would be light.

A hydrometer is a device used to measure density. It is a glass tube weighted at the bottom so that it floats at a certain level in the water. Inexpensive hydrometers may be purchased at aquarium shops. Density becomes greater with increased saltiness. The saltier the water, the higher the hydrometer will float. The numbers on the hydrometer scale run from 1.000 to 1.025.

Before reading the hydrometer, unplug the air pump to calm the surface of the water. Density is also affected by temperature. Use the chart below to find the appropriate density of seawater at each temperature.

If the water is too salty (that is, if the hydrometer reading is higher than the number on the chart), add fresh water until the hydrometer floats at the correct level.

Temperature	Density
60 degrees	1.0240-1.0245
65 "	1.0235-1.0240
70 "	1.0230-1.0235
75 "	1.0225-1.0230
80 "	1.0220-1.0225

Feeding

Most marine animals thrive on a diet of frozen fish or clams. Overfeeding can be a major problem. The animals should be able to clean up all their food in about 5 minutes. Remove any leftovers before they foul the tank. They can be removed with a turkey baster, which is less expensive than an aquarium vacuum.

General Maintenance

A gallon jar aquarium can generally support two or three animals, depending upon their size. If any of the animals looks sick, remove it immediately to a "hospital tank".

Algae can be carefully scraped off the walls of the tank with a single-edged razor blade and sucked out with the kitchen baster.

Cloudy water generally indicates an unwanted growth of bacteria. The best thing to do in this case is to start the tank over again with new water.

Tank water can easily become poisoned. Make sure that no metal ever comes in contact with the water. If you suspect that the tank has been poisoned, dilute the poison by changing about half of the water immediately.

Have your students keep a daily log of their tank. Have them record information about pH, temperature, salinity, and any changes that they observe in the animals.

KEY - Results

A. Answers will depend upon the experimental data. The heartiest animals will be those still surviving.

B. The most difficult part of maintaining the aquarium will vary. For some students the daily observation and recording will be the most difficult. For others, the set-up will be the most difficult.

C. Two other factors mentioned in the activity which aquaculturalists have to watch include: salinity, temperature, overfeeding, and sunlight.

D. Aquaculturalists face lots of problems in raising their crop. These include: predators, disease, providing food, feeding, marketing, harvesting, and maintaining water chemistry. This question is designed to get your students to think back about what they've previously learned about aquaculture.

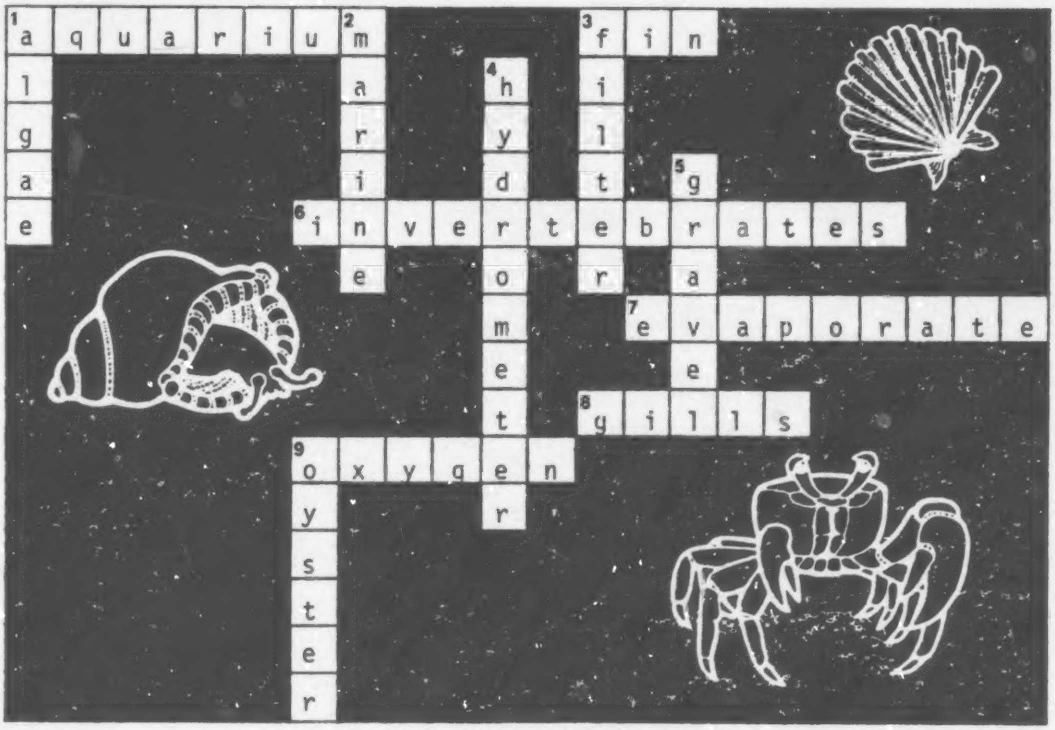
KEY - Crossword

Across

1. Tank in which we put plants and fish
3. Body part that allows a fish to move
6. Animals without backbones
7. When water [illegible]ges to vapor
8. Body part that a fish uses to breathe
9. What fish breathe

Down

1. Plant growth on sides of tank
2. Term meaning salt water
3. Device that cleans aquarium water
4. Device to measure density
5. Aquarium substrate
9. Animal that makes pearls


1 aquarium
1 algae
2 marine
3 fin
3 filter
4 hydrometer
5 gravel
6 invertebrates
7 evaporate
8 gills
9 oxygen
9 oyster

Developed by the New York City Sea Grant Office — Cornell University — Cooperative Extension

KEY WORDS

- algae
- aquaculturist
- aquaculture
- aquarium
- condition
- dissolved
- filter
- gills
- hydrometer
- invertebrates
- marine
- oxygen
- salinity
- survived
- tenant
- turkey baster

This Teacher Background material and crossword puzzle are adapted from "A Saltwater World in a Jar" by Linda J. O'Dierno, New York Sea Grant; 111 Broadway, 17th Floor; NY 10006.

WORLD IN A JAR

Aquaculture is tricky business. Keeping the animals alive and healthy is most important. Here's your chance to raise and care for marine animals. Who knows? Maybe this will lead to a career as an aquaculturalist. Good luck.

Materials - Here's what you'll need

glass gallon jar
seawater
crab
air pump
filter plate
airlift tube
airline tubing
crushed oyster shells or gravel
fish food (frozen fish/clams)

Procedure - Here's what to do

1. First, you'll need a wide-mouth one-gallon glass jar. Jars can often be obtained from your school cafeteria. If not, try local restaurants.

2. Clean the jar carefully. DON'T USE ANY SOAP. Soap will hurt marine animals. No matter how hard you try, you'll never remove the soap. If needed, use baking soda or salt instead of soap.

3. Select a location for your aquaculture project. Pick a sturdy table or countertop. It should be away from heaters and direct sunlight. Too much sun causes algae to grow in your jar aquarium. The cooler the site, the better. The saltwater animals you'll have like cool water. The animals

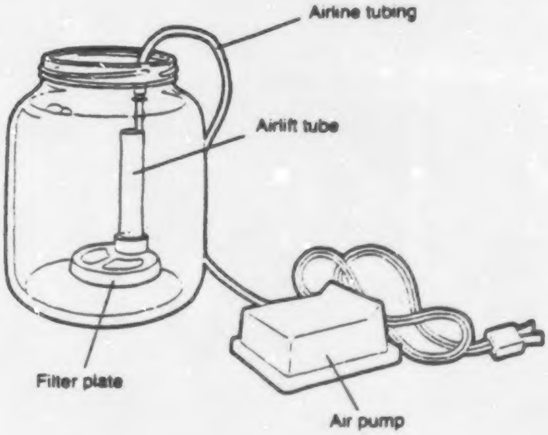
breathe the oxygen dissolved in the water. Cool water holds more oxygen than warm water. The animals take the water in through their mouths. They then pass the water over their gills. The gills remove the oxygen they need.

4. To keep the oxygen level high, you'll need an air pump. Use a goldfish bowl filter. This filter goes under the gravel in your jar. The air pump forces air bubbles into the water. The air bubbles move the water through the gravel. The gravel filters out wastes.

5. Next, you need material for the bottom of the jar. Place two inches of gravel over the filter plate.

6. Place a paper towel over your gravel. Carefully pour seawater into your jar. The towel will help keep the gravel in place. Fill the jar to its widest point. Remove the towel.

7. Connect airline tubing from the airlift tube to the airpump. Plug in the air pump. Bubbles should leave the airlift tube.



8. Now you need to condition the water. Place a small crab in the jar. At first, the crab will be your only tenant. Feed the crab small bits of frozen fish or clams. Overfeeding is a problem. Only feed what your crab can eat in about 5 minutes. Remove the leftovers before they foul the tank. You can remove them with a turkey baster.

9. After two weeks, you can add other animals. Your jar can support two or three small animals. Usually, invertebrates (animals without backbones) are the best tenants. Hermit crabs are a good choice. Provide some larger shells for new homes. If any of your animals look sick, remove them at once. You can place them in a "hospital tank".

10. There are some things to watch. The best temperature is that of the animal's natural habitat. This is usually cooler than room temperature. Try adding an ice cube every morning. This cools the water. It also replaces water that evaporates. When water evaporates, the salt is left behind. The water gets more salty. You can measure the "saltiness" (salinity) with a hydrometer. You can use a hydrometer to measure daily salinity. If you do, record your results in a table.

11. Keep a daily log of your tank. Record information about temperature and salinity. Note any changes that you observe in the animals. Here is a sample log. Use the sample to make your own log form.

LOG	Temperature	pH	Salinity	Animal condition
Oct. 1	75°	7.5	1.0225	
Oct. 2	80°	7.5	1.0220	
Oct. 3	80°	7.7	1.0225	Herman the hermit crab moved to a larger shell
Oct. 4	70°	8.0	1.0230	

Results - Here is what happened

After three weeks of operating your aquarium, answer these questions.

1. Have all of your animals survived? Which animals are best suited to life in a jar?

2. What was the most difficult part of maintaining your aquarium?

3. Aquaculturalists have to be aware of lots of things. They have to watch the oxygen level of the water. What are two other factors they have to watch?

   a.

   b.

4. What are some problems that aquaculturalists might face in raising their crop?

   a.

   b.

   c.

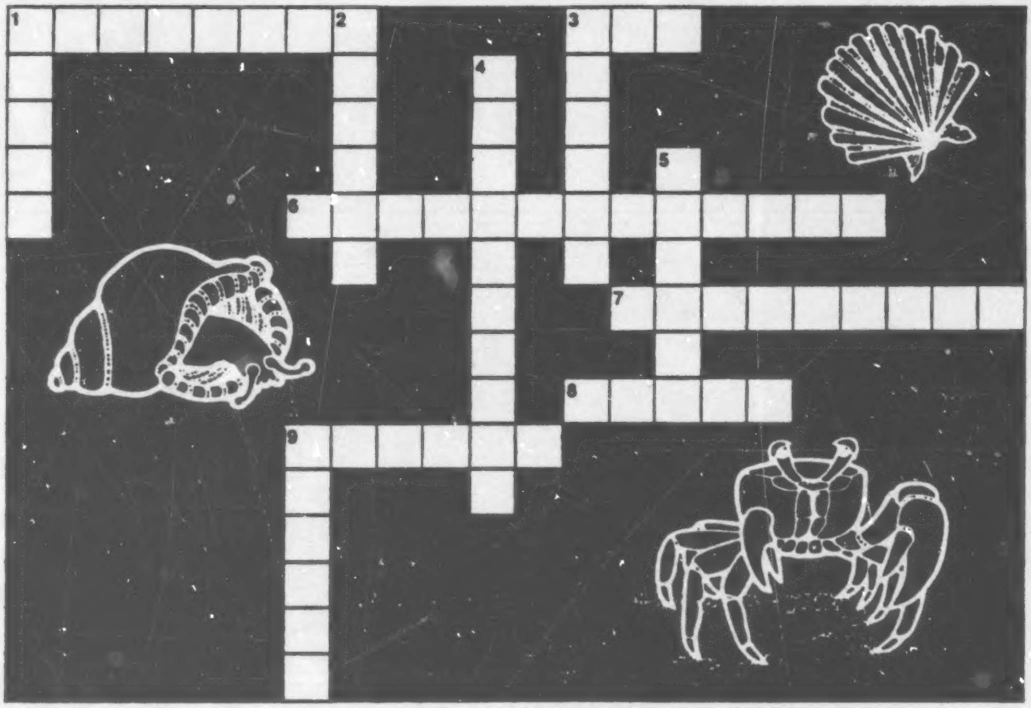
HERE'S A CROSSWORD TO HELP YOU REMEMBER WHAT YOU'VE LEARNED!

Across

1. Tank in which we put plants and fish
3. Body part that allows a fish to move
6. Animals without backbones
7. When water changes to vapor
8. Body part that a fish uses to breathe
9. What fish breathe

Down

1. Plant growth on sides of tank
2. Term meaning salt water
3. Device that cleans aquarium water
4. Device to measure density
5. Aquarium substrate
9. Animal that makes pearls



Developed by the New York City Sea Grant Office — Cornell University — Cooperative Extension

SUGGESTED ADDITIONAL ACTIVITIES

1. Contact your county extension agent for information about local aquaculture projects. Arrange to visit those nearby.
2. Visit the salmon raising project of Domsea Farms at Gorst Creek and Bainbridge Island.
3. Visit the National Marine Fisheries experimental station at Manchester.
4. Visit the Quilcene National Fish Hatchery in the fall of the year during the spawning season.

SEND - IN PAGE

Well, you've made it. Thank you for teaching about the marine environment. We worked hard to put this unit together and we would really like to hear from you. If you have any reactions (positive or negative) that could help us, please let us know. We are also interested in any changes you made in the activities which you feel made them more useful. If you have some marine activities that you have tried successfully with children, we would like to know about them also. Perhaps we can help you share your working ideas with other teachers concerned with the marine environment. Again thanks, and keep up the good work.